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AUTHOR	Meyer, G. R.
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ABSTRACT

The development of new courses is described and weaknesses are identified. The current position of the project is reviewed in terms of production of syllabuses and books, production of equipment, acceptability in schools, and administration and staffing. Biology syllabuses and textbooks are discussed in more detail. Appendices include reports of visits to schools, proposals for evaluation, suggested outlines for sections of the biology materials, a report of a research study on the acceptability of the biology course to students, and photographs of project personnel and Indian high schools. (EB)

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on : Three Months as Consultant for the
UNESCO Secondary School Science
Teaching Project for India
September to November, 1968.

by : G.R. Meyer, Ph.D.,
UNESCO Consultant,
Director,
Centre for Advancement of Teaching,
Macquarie University,
North Ryde. N.S.W. 2113. Australia

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SECTION 1. Summary and Main Conclusions

1.1 A project which began in 1965 largely as a task of translating Soviet courses-of-study and texts for use in Indian schools, has gradually emerged as a more creative project developing new curricula and original teaching materials. The team worked slowly from 1965 to 1967 partly because of problems of communication, partly because the team was incomplete and partly because of difficulties in finding a working agreement with Indian counterparts. As these problems have been overcome the tempo of production has increased.

1.2 During 1968 there have been adaptations and major revisions of courses first developed between 1965 and 1967. The courses now proposed for Middle School (with the possible exception of physics) are more in line with international trends in science teaching.

1.3 Courses designed in 1968 for Higher Secondary School are strongly influenced by trends in U.S.A. (NSF) and Britain (Nuffield) and will make science courses in India at this level consistent with accepted international trends.

1.4 The main weakness of the project so far has been lack of systematic evaluation and continuous feed-back from the schools. A design for a programme of evaluation has been proposed and accepted in principle by the UNESCO team and NCERT. An important part of this proposal is that evaluators be added to the team either as experts or consultants and that additional evaluators be appointed by the Indian Government.

1.5 Another major weakness has been that the first members of the team wrote for only one pattern of Indian education and that their materials must now be adapted for alternative patterns. Solutions to this problem are proposed with special reference to biology.

1.6 The project is in need of stronger international influence by using more part-time non-Soviet consultants who would each return at regular intervals. My own experience suggests that this international co-operation would be welcomed by the experts.

1.7 The science workshop attached to the project is not functioning satisfactorily. It should be involved more with teachers and should be making more generalised and improvised equipment.

1.8 The materials produced for Middle Schools are being taught with varying degrees of success. Lack of systematic feed-back has led to some books being out of tune with the real situation in schools. Proposals are made to overcome this problem. There is, however, keen interest in the work amongst most pupils, especially in biology and chemistry.

1.9 Materials produced by the UNESCO team and by the NCERT Study Groups provide the States with a choice of alternative courses. At first these projects were widely divergent. Recent revisions by both groups has, fortunately, brought the courses closer together. For example, new syllabuses for Higher Secondary School in biology are now very similar in both UNESCO and Study Group drafts.

SECTION 2. Terms of Reference and Their Interpretation

2.1 The terms of reference in the contract with UNESCO were as follows :

A. to meet with the team of experts at the Secondary Science Teaching Project in India and discuss the methods of work in writing out new courses of study and in preparing new teaching materials as well as the ways and means of in-service training of science and mathematics teachers;

B. to hold seminars with the university staff engaged in reform of school curricula;

C. at the invitation of university faculties and education authorities deliver lectures on my special fields of research;

D. to submit a report to UNESCO on completion of the mission.

2.2 My teaching experience and qualifications in science education are mainly in biology. Paragraph 2.1A was, therefore, interpreted by the Chief of Mission and by the Director of the Science Education Department of the National Council for Educational Research and Training as work mainly in the field of biology curriculum. In addition, as much of my work in Australia has been to evaluate achievements of pupils in science and to analyse the attainment of the objectives of science curricula, the in-service training aspects was interpreted as work with schools and teachers mainly in evaluation. In this way it was considered that local teachers would gain some training in techniques of evaluation, while at the same time giving the science teaching project a model for the implementation of a more rigorous system of continuous evaluation (and hence feed-back) of materials produced. Work in evaluation was to be mainly in biology but I was also to help produce models for the evaluation of syllabuses and textbooks in chemistry, physics and mathematics.

SECTION 3. The Current Position of the Project as a Whole

A. Production of Syllabuses and Books

3.1 According to the Recommendations of the Education Commission (1964 to 1966) separate sciences were to replace general science in the Indian Middle Schools. The UNESCO Science Teaching Project, therefore, aimed to produce separate courses for the Middle School in physics, biology and chemistry. This was planned, however, on the assumption, that all pupils will take all these subjects so that there would be a tightly correlated programme of science and mathematics catering both for general education and providing a base for further study in special sciences in the Higher Secondary School.

3.2 This objective has been achieved. Science syllabuses and pilot editions of books are now available for classes VI, VII and VIII in biology, physics and mathematics and for classes VII and VIII in chemistry. Teachers' Guides are either published or almost ready for publication.

In the main, these courses are based on sound principles of curriculum construction in that they have clearly defined objectives and strong internally consistant structure. They of course, reflect trends in science teaching in the Soviet Union.

While materials for Middle School are, on the whole, adequate as preliminary editions, there are two central problems in their final revision and editing.

i. The team of experts does not have sufficient backing from Indian counterparts adequately trained in the techniques of evaluation. Revision so far has been based on ad hoc feed-back and generalised reports from teachers in experimental schools. There is need for a more thorough systematic collection of data. This kind of information of course, is best collected by Indian evaluators who have no problems of communication with pupils or teachers and who thoroughly understand the local system of education.

ii. When the materials were first planned, a wide-spread pattern in Indian schools was to have five years in Primary School followed by three years in Middle School (classes VI, VII and VIII). The Education Commission, however, has recommended (1964) a change to 4 + 2 or 3 so that Middle School would begin in class V. Materials produced by the UNESCO team, especially in biology and physics, had in mind pupils of classes VI, VII and VIII. In revising the materials some method has to be found to cater both for pupils who start Middle School in class V and for those who start in class VI. This problem is not acute in mathematics or chemistry because the materials appear to have been prepared at levels appropriate for either class V or class VI. The solution to the problem in physics and biology requires experimental comparisons between classes V and VI. Because of shortage of time I was only able to undertake this for biology. A report of this experiment and the solution proposed is given below - Section 8.3 and Appendix E.

3.3 The project is now moving into its second phase. Draft syllabuses have been prepared in chemistry, physics, biology and mathematics for the Higher Secondary School, and content specifications made for the first textbook for each subject. I was impressed with this phase of the project. The following features, especially in biology, chemistry and mathematics are very satisfactory.

i. While care has been taken to use Indian criteria for the selection of topics, current trends in curriculum in Australia, Britain (especially Nuffield), the Soviet Union, and the United States (especially the various NSF programmes) have strongly influenced the philosophy of the curricula. The course will be consistent with the best international trends in the teaching of science and mathematics.

ii. It has been recognised that materials must now be prepared for pupils coming to Higher Secondary School from Middle Schools of two basic types (classes V, VI and VII; or VI, VII and VIII). Courses and content specifications have catered for this difference by appropriate arrangement of subject matter and by developing writing styles suitable for the two age ranges.

3.4 The programme and content specifications in physics and Higher Secondary School follows the approach of classical physics. While recognising that this is largely personal opinion and a matter of some controversy in science education, I would have preferred the course to follow current developments in Britain (Nuffield "A" level), Australia (N.S.W. Higher School Certificate), or the U.S.A. (Harvard Project Physics).

3.5 As in the case of the revision of Middle School materials, the production of courses and textbooks for the Higher Secondary School should involve a system of continuous evaluation (and feed-back) as materials are being written. This is probably even more necessary for the Higher Secondary School than for Middle School because the courses, with the possible exception of physics, are very new and revolutionary in approach as far as the Indian educational system is concerned. This makes it critically urgent that appropriate Indian evaluators be appointed as early as possible during this phase. Systematic feed-back can then come from the outset and continue during production. This should greatly speed up the production of the final editions.

3.6 Related to this latter problem (3.5) is the need to strengthen the academic help provided by the Indian Government. The present counterparts (staff of NCERT) have, in the main, been excellent partners in the production of materials for Middle School. The new courses proposed for the Higher Secondary School, however, are very modern and contain concepts requiring development by highly skilled scientists who are at the same time skilled teachers. The Indian contribution to the project should be strengthened in this regard.

3.7 A serious problem for the project lies in the gap between publication dates of English and Hindi editions of textbooks. For example the chemistry text for class VIII was available for the beginning of term (July 1968) but the Hindi edition (needed by almost all pupils in Delhi) is not yet available, and duplicated versions of chapters 1 and 2 were given to schools as recently as 13th November, 1968. It is hard to apportion blame for this delay, but if the counterpart had been preparing simultaneous translations as the material was being written the editions would have been issued simultaneously.

SECTION 4. The Current Position of the Project as a Whole

B. Production of Equipment

4.1 It was not possible to analyze the production of equipment in detail as most time was given to curriculum and evaluation. However, the following impressions were gained :

i. Production of kits for chemistry seem functional and well designed, but are perhaps over-elaborate for the needs of Middle Schools.

ii. Although I could not explore the economics of this, I have the impression that not enough is being done to find sources of ready-made equipment. Some specifically designed items with minor adaptations, may well have been bought 'ready-made' at lower cost.

iii. One considerable merit is that materials produced exactly match the needs of the course. Sometimes, however, this has caused equipment to be made with rather specialised and limited use.

iv. Not enough use is being made of improvisation along the lines recommended in the UNESCO source book for science teachers.

v. Insufficient use is being made of the workshop for the in-service training of teachers. For example, no special 'workroom' has been set aside for teachers to come and make items of equipment without interference with the general production. Insufficient use is being made of equipment for training teachers in the 'art of improvisation'.

4.2 The most interesting and efficient workshop of this type that I have seen in a developing country is in the Science Teaching Centre in Nairobi (but that was in March 1966). Perhaps it may be possible to arrange for a short-term consultant who has worked in that Centre to visit Delhi to help with organisation of the workshop there.

SECTION 5. The Current Position of the Project as a Whole

C. Acceptability in Schools

5.1 It was possible to visit 'UNESCO Experimental Schools' in Delhi and Hyderabad. In addition, non-experimental schools were visited in these two cities and also in Madras. A list of schools visited is given as Appendix A. In addition, a study in depth was made of the acceptability of the biology materials in classes V and VI of the NCERT Demonstration School (see Section 8.3 and Appendix E).

In all schools, teachers were interviewed, lessons observed, notebooks examined and where possible oral tests administered. In almost all schools I taught one class (sometimes more than one) for a proportion of a period - sometimes in English and sometimes in the local mother tongue with the aid of an interpreter.

5.2 I gained the following impressions :

i. Biology was very well received. The interest was very high. In particular there was an enthusiastic response to the experimental work, to field trips and to handling biological specimens in the laboratory or classroom.

ii. Chemistry was successful and popular but physics relatively unpopular (great interest in practical work in chemistry, less interest in practical physics).

iii. Mathematics appeared to be causing some difficulty. Pupils were less interested in mathematics than in the sciences and had more difficulty in grasping the concepts.

iv. In the VI class of all schools there was some difficulty in teaching the logic of the scientific method. For example, pupils had difficulty in seeing the purpose of a 'control' or to follow the deductive steps in reasoning from data to conclusion.

v. All courses were too long. Teachers were under strain to complete the programme.

5.3 On the whole the materials for classes VI, VII and VIII appear to be satisfactory for urban schools. All courses and books are now under revision and most of the difficulties appear to have been overcome. They would have been overcome earlier had there been a mechanism of continuous feed-back as materials were being written in the first place.

5.4 Detailed recommendations for modification of syllabus and textbooks in biology for Middle School were prepared and are discussed below (Section 8 and Appendices C, D and E).

SECTION 6. The Current Position of the Project as a Whole

D. Administration and Staffing

6.1 There is considerable merit in having a UNESCO team drawn largely from one country - in this instance from the Soviet Union. This gives a strongly united homogeneous group with clearly defined and agreed objectives. The obvious dangers of 'cultural bias' could be largely overcome by the use of short-term consultants from other countries. I strongly recommend that in this instance the use of the short-term consultant be a major feature of the programme. The consultants should return regularly to the project to ensure follow-up of their recommendations. Such consultants should be science educationists rather than subject specialists.

6.2 I personally found no difficulty in identifying with the team and work involved far more than an'exchange of views'. All suggestions, recommendations and advice were discussed fully and carefully and usually either adopted completely or in part. I found my UNESCO colleagues adaptable and most willing to consider and act on new points of view. It was this flexibility and adaptability (and I speak now especially of the biologists with whom I worked most closely), that convinced me that short-term consultants from other countries would be welcomed. Provided he could identify quickly with the group, such a consultant could exert considerable influence and accelerate progress.

6.3 The relationship between the UNESCO expert and his counterpart is complex. I found that with the exception of one or two unsatisfactory 'pairs' (none in biology) the relationships were good. Certainly there were no clashes of personalities. Problems arose when the expert tried too hard to speed up production. This project has taken quite a long time to produce its first pilot editions. At least part of the explanation is in the tactful handling of the counterparts by the experts. If the project is to have lasting meaning and value, it must in essence, be the product of the Indian counterparts. Restraint by the experts who are greatly tempted to 'write quickly to get a book produced' has meant a much greater Indian involvement - at the expense, of course, of the time schedule. Pressure on a counterpart from an expert only results in confusion and badly produced material. Materials written by experts alone have no meaning for Indian education. The method adopted by this team is the right method, but it is also the slow method. Nevertheless, rate of progress in the early stages was surprisingly slow. Tempo of production, however, now seems satisfactory.

6.4 There are two other explanations for the relatively slow rate of production in the initial stages of the project. Firstly, a team of purely Soviet Experts has difficulties in communication with Indian counterparts, teachers and pupils. Stronger international influence by means of short-term consultants, would accelerate production. Secondly, the team was incomplete for some time during the period 1965 to 1967.

6.5 The number of permanent experts on this project is adequate in number only if (a) they are supported by a stronger team of Indian counterparts, especially evaluators and good scientists for the Higher Secondary phase and, (b) there is a continuous flow of short-term consultants from a variety of countries with sophisticated science curricula.

SECTION 7. The Need for Evaluation

7.1 The need for strengthening the systems of evaluation and feed-back have been stressed above. A modest proposal for evaluating the project was prepared in consultation with one UNESCO expert and one Indian counterpart. This proposal is attached as Appendix B. This proposal was accepted by NCERT and a workshop for constructing test items was held in November, 1968. The prototypes of ten unit tests were successfully constructed during this workshop and a plan of operation for future phases of the evaluation programme approved in principle by NCERT.

7.2 Successful continuation of this programme is dependent on the appointment of appropriate Indian counterparts and on the use of short-term consultants (or a permanent expert) who could advise and direct the programme.

SECTION 8. Biology Syllabuses and Textbooks : UNESCO/NCERT

8.1 My first task in September 1968 was to help with the revision of the biology syllabus for Middle School. Proposals for amendment recommended reduction in content, breakdown of the formal phylogenetic treatment characteristic of the traditional curriculum to give a more applied and ecological approach, and to introduce a new section at the end of the course on the interaction between man and his environment. The report on this syllabus is attached as Appendix C. Almost all the recommendations have been adopted with the exception of the suggestion that microscope work be omitted from Middle School. UNESCO experts were largely in favour of its omission but Indian counterparts wished this work to remain. The revision of this syllabus with the strengthening of the environmental aspect, brings it more into line with international trends in the teaching of biology.

8.2 The textbooks produced by the UNESCO/NCERT team in biology for use in Middle Schools were analysed. A general report on these books is presented as Appendix D. Recommendations suggested some reduction in content, simplification of style and improvement of illustrations and questions. On the whole the alterations required to these books for successful use in classes VI, VII and VIII would be relatively minor provided they are also brought into line with the revised syllabus.

8.3 As mentioned above (Section 5.1) a detailed research study was completed on the acceptability in class V of biology materials produced for class VI. The report of this study is attached as Appendix E. The main recommendations were as follows : (i) if books II and III were shortened and simplified, they could be used under either Scheme 'V, VI and VII' or 'VI, VII and VIII', (ii) Book I, however, should have two editions one for each scheme. Details of the recommendations are given in Appendix E.

8.4 At this point it is impossible to avoid a serious criticism. The plan of production should, at the outset, have catered for the two patterns of education in Middle School. These two patterns existed at the outset of the project and the change to the V, VI, VII scheme had been foreshadowed at that time by the Education Commission. It is hard to see how this obvious point could have been overlooked. It is very much more luck than good management that will enable this problem to be overcome in the way recommended in Appendix E.

8.5 The proposed syllabus for Higher Secondary School in biology closely follows the Yellow version of the BSCS with appropriate modifications for Indian schools. While this is an excellent programme, it does pose certain problems for implementation in India and some of them are considered in Appendix F.

8.6 A content specification for the first volume of the text books for class IX was produced as an advisory document at the request of the UNESCO Biologists. This is attached as Appendix G.

SECTION 9. Relationship Between UNESCO/NCERT Biology and Study Group/NCERT Biology

9.1 The materials produced by the NCERT Study Groups were at first developed independently of the UNESCO project. Fortunately a number of joint consultations and seminars have moved these two projects closer together.

9.2 The syllabus and textbooks produced by the Study Groups for Middle School are not very satisfactory. While the biology is good, basic principles of curriculum construction have been ignored. A report was submitted to the Study Groups at their request and, if the recommendations in that report are accepted, the syllabus and text for Middle Schools will be brought more in to line with the UNESCO materials. This report is attached as Appendix H.

9.3 At a conference with the Study Groups in Madras I was able to assist with the final draft of the syllabus in biology for Higher Secondary School. This is now very much more like the syllabus proposed by the UNESCO team and the two courses are by no means incompatible. See Appendix A.

SECTION 10. Relationship with Science Talent Quest

10.1 The UNESCO experts have been asked to help with seminars and workshops for the above project. For example, a course of lectures in biology was proposed and submitted to a "Seminar on Identification and Nurturing of Scientific Talents", October 14 - 16, 1968. This was organised by the Department of Extension Services of the Central Institute of Education, Delhi-7.

10.2 A word of caution should be introduced here. This is essentially a peripheral activity of NCERT and the time and energy of the UNESCO experts should be used sparingly in activities other than those central to their main task.

SECTION 11. Lectures and Seminars

11.1 As specified in Section 2 a number of seminars, talks and lectures were given. These are listed in Appendix J.

APPENDIX A

LIST OF SCHOOLS VISITED AND A REPORT ON VISITS TO MADRAS AND HYDERABAD

A$_1$. List of Schools Visited

Delhi

1. The Mothers School, Aurobindo Marg, New Delhi-16.
Principal : Mr. M.P. Chhya
Biology teacher : Mrs. M. Pathrose

2. Model G.G.H.S.S. No. 1 Sarojini Nagar, New Delhi-3.
Principal : Mrs. P. Hira Singh
Biology teacher : Mrs. S.L. Vedehra

3. G.G.H.S.S. Bela Road, Delhi.
Principal : Mrs. S.R. Soiri
Biology teacher : Mrs. S. Siddique

4. G.H.S.S. No. 1 Sarojini Nagar, New Delhi-3.
Principal : Mr. B.S. Chanham
Science teacher : Mr. P.S. John

5. G.H.S.S. Mehrauli II, New Delhi-30.
Principal : Mr. Sohan Dal Gam
Science staff

6. Springdales School, Pusa Road, New Delhi-5.
Principal : Mrs. Rajni Kumar
Biology teacher : Mrs. C. Tangri

7. G.H.S.S. Bashai Dara Pur, New Delhi-15.
Principal : Mr. S.N. Tewari
Science teacher : Mr. Param Singh

Madras

8. Madras Christian College School, Chetpat, Madras-3.
Headmaster : Mr. E.D. Savarirayan
Science staff

Madras (continued)

9. Corley High School, Tambaram.
   Headmaster : Mr. S. Thomas
   Head clerk : Mr. L.M. Peyamogana
10. Baby Middle School, Tambaram, Madras-45.
   Headmaster : Mr. K. Dorairaj
   Assistants : Mr. V. Pattabiraman
   Mr. M. Thyagarajan

Hyderabad

11. Government Multipurpose High School, Nampalli.
   Headmaster : Mr. S.M. Rairndra
   Science staff
12. Wesley Boys' Multipurpose School, Secunderabad.
   Principal : Mr. T.P. Sadanandaw
   Science staff
13. Government Boys' High School, Nallagutta, Secunderabad
   Headmaster : Mr. P. Anjameynhi
   Science staff
14. Government Boys' High School, Irrum Manzil, Hyderabad-34.
   Headmaster : Mr. K.V. Madhusudham Rao
   Assistant : Mr. A. Prabhaker Rao

A_2. REPORT FROM DR. G.R. MEYER TO PROFESSOR S.A. BALEZIN AND DR. M.C. PANT ON VISITS TO EDUCATIONAL INSTITUTES IN MADRAS AND HYDERABAD

25th TO 31st OCTOBER, 1968.

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1. Objectives of Visits

The main purpose of the visit to Madras was to develop contacts with the Study Groups of the NCERT in Biology meeting in Madras for a national conference from the 24th to 26th October, 1968. These groups sought advice on the text books for Middle School Grades VI, VII and VIII produced by their committee and on the construction of a course of studies in biology for Grades IX, X and XI.

A further purpose was to study schools in the Madras district with a view to (i) offering comments and advice on teaching methods and, (ii) giving the UNESCO Science Teaching Project further understanding of the standards of education in schools in Madras State.

The central objective in visiting Hyderabad was for discussions with the staff of the Science Education Department of the State Council for Educational Research and Training on the adaptation of the UNESCO Science Teaching Project materials for use in the State of Andhra Pradesh. Opportunities were also taken to obtain further evidence on overall standards of education in Andhra Pradesh on general problems of science education and, in particular, on aspects of the teaching of biology. Detailed visits were, therefore, paid to the Botany, Zoology and Chemistry Department of Osmania University, to the offices of the Mobile Science Van of the Andhra Pradesh Akademi of Sciences, and to representative schools in and near Hyderabad. As in Madras, advice was given when sought by teachers on teaching methods and on classroom and laboratory organisation.

2. Itinerary

Friday, 25th October

Morning	Travel New Delhi to Madras
Afternoon	Discussion with Biology Study Group on text books of Biology for Grades VI, VII and VIII.

Saturday, 26th October

Morning	Further discussion with Biology Study Group on text books.
Afternoon	Participation in Seminar of Biology Study Group on construction of syllabus in Biology for Grades IX, X and XI

Monday, 27th October

Morning i) Discussions with representatives of Directorate of Education on system of education in Madras State.

ii) Visit to Madras Christian College School, Chetpat, Madras. 3.

Afternoon i) Visit to Corley High School, Tambaram.

ii) Visit to Baby Middle School, Tambaram.

Tuesday, 29th October

Morning i) Travel Madras to Hyderabad.

ii) Visit to the headquarters of the Mobile Science Van of the Andhra Pradesh Akademi of Sciences.

Afternoon i) Visit to Government Multipurpose High School, Nampalli.

ii) Visit to the Department of Science Education of the State Council of Educational Research and Training.

Wednesday, 30th October

Morning Visit to Wesley Boys Multipurpose School, Secunderabad.

Afternoon i) Visit to Government Boys High School, Nallagutta, Secunderabad.

ii) Visit to Government Boys High School Irrum Manzil, Hyderabad. 34.

Thursday, 31st October

Morning i) Discussions with Professor Suxena, Head of School of Botany, Osmania University on the structure of university education in the sciences in Andhra Pradesh.

ii) Visits to the Botany, Zoology and Chemistry Departments of Osmania University.

Afternoon Travel Hyderabad to New Delhi.

3. Reports on Specific Topics

3.1 Report to the Biology Study Group on Texts for Grades VI to VII.

The basic criteria and objectives for choosing the topics and chapters for the entire course as a whole must be clearly spelt out in the first instance. The books contain too much material in too overcrowded a manner. More emphasis has been laid on morphological and less on functional aspects. It was felt that some descriptive matter should be cut out and more illustrations provided in their stead. Form and functions should not be separated but integrated. Clearly defined objectives, produced even now, would provide criteria for selecting or rejecting items.

The Indian fauna and flora, however, are adequately represented in the text and this is very satisfactory.

The diagrams are uneven in quality and uncertain in function. They need to be divided into two categories :- (1) Those that the authors expect the pupils to learn by heart. These should be one dimensional clear drawings without shading etc. (2) Artistic types of drawings meant for merely looking at by the child. In this context it may be pointed out that the BSCS figures are too 'arty'.

In all the three books there is very little of the enquiry approach. In the middle schools, however, this cannot be pushed too far. The deficiency could be overcome by some rearrangement and re-orientation. Book I can begin with a modified version of the chapter on 'Experimenting With the Living' and then the subsequent chapters may be oriented with an emphasis on the concepts given in this new Chapter I. The chapter on dispersal is out of context and should be omitted.

Chapter II may be replaced by 'How a Green Plant Works' and Chapter III omitted altogether, being conceptually better catered for by 'How an Animal Body Works' - taking the human body itself as the case study and placed in Book II. Chapter on 'Naming and Classifying' must emphasise the concept that classification is a key scientific process and should be developed in line with the proposed new Chapter I.

In Book II 'Microscope' may be omitted and a simpler account of the cell and cell division given which does not involve the microscope.

The chapter on 'Life Processes' in Book II is unsatisfactory as it deals with the various physiological processes more in the way of an abstraction that extends to the whole of the biological world. In this section too there is much repetition of concepts but without any benefits from repetition. This would be difficult for the pupils to comprehend. Instead of animals and plants being torn apart to artificially bring together processes, these processes should be introduced more naturally as integrated phenomena within an organism - say in a green plant and a human body. This would be easier for the students to understand and they would also better appreciate the inter-relationships between the various processes within an organism. It would also cut down the length of the course by reducing the repetition of similar concepts.

Book III is excellent except that as already mentioned the 'Human Body' could be dealt with in Book II.

Teacher training is needed for implementing the course and a statement of the syllabus and of the objectives of the syllabus should be widely circulated amongst university departments of biology and amongst staff of teacher training institutions as soon as possible after the final editions are produced.

In summary the contents of the books should be rearranged as follows :

Vol. I (Grades 5/6)	"Experimenting With Living" "How a Green Plant Works" "Naming and Classifying" "Beginning the Story of Diversity"
Vol. II (Grades 6/7)	"How an Animal Works - Man" "Continuing the Story of Diversity"
Vol. III (Grades 7/8)	"Explaining Diversity - Evolution" ("Explaining Diversity - Genetics") - only if considered suitable for Middle School Rest of content of present Vol. III less structure and function of man which would now be in Vol. II.

3.2 Study Group Syllabus in Biology for Grades 9 - 11.

The first draft of this syllabus was discussed on Saturday, 26th October. It was possible to influence the seminar to include some topics from the proposed UNESCO syllabus grades 9, 10 and 11. These topics included 'Conversation', 'Animal Behaviour', 'Study in Depth of Two or Three Topics from the Whole Organism', and 'The Population Biology of Man'.

The final syllabus is now not too unlike the one produced by the UNESCO team with the exception that there is perhaps more emphasis on community ecology. The sections on cell biology are closely parallel in the two syllabuses.

3.3 Schools in Madras

It was possible to visit only three schools in Madras - two High Schools and one Baby Middle School.

In general the standards of the High Schools were satisfactory except for severe overcrowding of classes - 50+ children in each section. The curriculum in Madras is more rigid than in Delhi and does not give much emphasis to general education - art and music are badly neglected for example, and there is insufficient choice of subjects to cater for individual differences.

Science courses in Madras are stereotyped and traditional with formal experiments to be completed in chemistry and formal dissections and demonstrations to be undertaken in biology of the type abandoned many years ago in Australia and U.S.A. Science facilities in the schools are reasonable except for a generally low level of maintenance of the laboratories - especially in chemistry. Techniques of teaching descriptive biology and classical physics seem reasonably satisfactory but experimental methods in chemistry and biology seem well below international standards.

Conditions in the Baby Middle School were unsatisfactory because of severe overcrowding and because the style of school buildings merged each class into the next. There were no really isolated classrooms. Use of slates for teaching 'number' and writing showed that the school was using very formal methods. There is no evidence that modern methods of teaching (e.g. integrated day) in the primary school have made any impact. Yet the attitudes of the pupils and the teachers were excellent.

3.4 Work of the Science Education Department of SCERT Hyderabad with Special Reference to the UNESCO Science Teaching Project

This centre has ambitious plans for the next few years. In primary teacher education, for example, it is planned to offer Summer Orientation programmes to Secondary Grade teachers to teach UNESCO syllabuses in 100 training schools. There are also schemes for developing and supplying equipment and for preparing syllabus for teacher education in science. In the secondary field it is intended to pursue the following objectives.

1. In-service training of graduate assistants
2. In-service training for secondary grade assistants
3. Improving pre-service teacher training curriculum and methods
4. Conducting survey of enrolment and resources available in laboratories
5. Curriculum research and field studies
6. Producing reading materials for teachers and pupils
7. Developing prototypes of apparatus and equipment according to the requirements of new syllabus
8. Developing designs for manufacture of apparatus

9. Producing and supplying equipment to institutions
10. Serving as liaison between State Department, NCERT, Ministry of Education, etc.
11. Training necessary personnel of the zonal centres. To fulfil all these requirements, there is need to strengthen this department.

The centre has excellent well equipped science laboratories but is short of key visual aids. Chemistry kits in boxes are available for distribution to schools.

The introduction of the UNESCO syllabus to the Middle School is well under way. The adapted syllabus for class VI will be tried out during 1968-69 and for VII in 1969-70, and in the first year of the IV Plan, and the next three years at the secondary level.

3.5 Educational Activities of the Andhra Pradesh Akademi of Sciences

This Akademi consists of about 50 Fellows and has a budget of Rs. 75,000 per annum, about half of which is spent on science education.

Educational activities include sponsoring popular science lectures; the translation of popular science books into the local language; sponsoring of astronomy and natural history clubs; and mobile science van for taking experimental science to remote village schools. The latter service is highly organised and very successful. 18 demonstrations and experiments are available in biology; 13 + 9 in chemistry; and 17 in physics. In addition, a number of individual projects in science can be supervised. This is a most important scheme, that must have achieved a considerable improvement in science teaching in rural areas of the State.

3.6 Schools in Hyderabad

As in Madras the curriculum is relatively inflexible and does not cater sufficiently for individual differences in ability and interest. Cultural subjects such as art and music are badly neglected.

Four High Schools were visited in and near Hyderabad. All were of a satisfactory standard except the Government High School at Irrum Manzil (Hyderabad-34) which had an inadequate science room. As in Madras, however, the science syllabuses were traditional and stereotyped. The UNESCO syllabus should introduce a note of well needed reform.

3.7 Science Departments of Osmania University, Hyderabad

Some time was spent inspecting the Departments of Botany, Zoology and Chemistry at Osmania University and interviewing post-graduate students. The

Botany and Chemistry Departments are well equipped and the courses are generally modern and up-to-date. There is a tendency, though, to try to cover too much ground in the botany programme. Criteria have not been established for eliminating some content to make room for modern aspects of botany. The Zoology Department is very strong in parasitology but otherwise is traditional in orientation with emphasis on systematics and structure.

The Chemistry and Botany Departments are both active in helping to up-grade science teaching in the schools of the State.

APPENDIX B

A PROPOSAL TO DR. M.C. PANT, HEAD OF THE DEPARTMENT OF SCIENCE EDUCATION, AND TO PROFESSOR S.A. BALEZIN, CHIEF TECHNICAL ADVISOR UNESCO, FOR A PROGRAMME TO EVALUATE THE EFFECTIVENESS OF THE MATERIALS PRODUCED BY THE NCERT/UNESCO SCHOOL SCIENCE PROJECT IN DELHI SCHOOLS

I. Background

1. Thirty-one experimental, i.e. Government, Municipal Corporation, Public and Private schools have been using the courses of the experimental project of teaching science and mathematics since July, 1966. These schools have been giving feed-back to the project.
2. Out of 31 schools about 25 will be sending candidates for the public examination for class VIII to be held in March 1969.
3. In addition to 31 Delhi schools, 118 central schools introduced the teaching materials in class VI from 1967. No feed-back has been received so far from these schools.
4. About 450 schools under the Delhi Administration have also started using the materials in class VI from July 1968.

II. The Need for Evaluation

1. To determine the suitability of the materials and concepts involved therein for the various age levels and abilities of the students.
2. To discover the interest aroused among pupils by the new courses.
3. To investigate problems of implementing the courses, e.g. nature of practical facilities, time devoted for each subject and topics, and administrative problems.
4. To give detailed feed-back on the effectiveness of each chapter of the books in order to make further improvements more effective.
5. To provide some basis to the various State educational authorities in India for adapting or adopting the materials of the project for their schools.

III. Nature of the Data Required

For biology, chemistry, physics and mathematics the following type of information should be obtained :

1. Appraisal by teacher of factors such as :-

a) Problems in the implementation of the project including facilities available in schools.
b) Assimilation of material by the students.
c) Difficulties faced by the students in learning new materials.
d) Degree of interest displayed by the pupils.
e) Amount of the text material covered.
f) Style of the textbooks.
g) Suitability and relevance of illustrations given in the books.
h) Effectiveness of the questions given in the textbook.
i) Comments on the Teachers' Guides.

2. Observation of the selected classroom lessons to assess the validity of data collected from the teacher.
3. Achievement tests administered to the pupils for each major unit of each textbook

IV. Plan of Evaluation

Because of the limited facilities available in the Science Education Dept. of NCERT for evaluation, the size of the sample should include not more than nine schools or nine subject groups. As far as possible this small sample should be a representative sample and should be sub-divided as follows for each subject :

Group 1. Three schools rated as being most successful with the new materials : (one Co-ed Private, one Government B.H.S.S., one Government G.H.S.S.).

Group 2. Three schools rated as being only indifferently successful with the materials : (one Co-ed Private, one Government B.H.S.S., one Government G.H.S.S.).

Group 3. Three schools rated as being less successful with the new materials : (one Co-ed Private, one Government B.H.S.S., one Government G.H.S.S.).

Step I. Rating the schools for selecting the samples.

The officers of DSE and UNESCO experts can be divided into the following two groups :

Group I	Group II
Mr. K.S. Bhandari	Dr. B. Atreya
Mr. S.P. Sharma	Shri G. Raju
Mr. K.J. Khurana	Mr. R.C. Sharma
Dr. B. Brared	Mr. Chhotan-Singh
Dr. A. Tamarin	Dr. V. Baulin
Mr. K.V. Rao	Dr. A. Margolis
Dr. V. Galushin	Dr. V. Galkhov
Dr. L. Levchuk	Dr. I. Narmov

or four groups :

Group I	Group II	Group III	Group IV
Mr. K.S. Bhandari	Mr. K.J. Khurana	Dr. D. Attreya	Mr. R.C. Sharma
Mr. S.P. Sharma	Dr. K.V. Rao	Sh. G. Raju	Mr. Chhotan-Singh
Dr. B. Brared	Dr. V. Galushin	Dr. V. Baulin	Dr. V. Galakhov
Dr. A. Tamarin	Dr. L. Levchuk	Dr. A. Margolis	Dr. I. Narmov

If there will be two groups then each group will be responsible at the first stage for rating 15-16 experimental schools. If there will be four groups, then each group will be responsible for rating 7 to 8 schools.

Each school will be rated according to the three categories mentioned above (in para IV). The main criteria for rating the schools may be as follows :

1. Qualification of the teacher involved in the project.
2. Practical facilities available in a school (whether a school has been equipped to teach science subjects or not).
3. The materials assimilated by the students. This should be judged on the basis of (a) result of the examination for the previous class, (b) day to day , monthly and other tests, etc. and (c) observation of teaching-learning process in classroom situations.
4. Amount of materials in science subjects covered in each class.
5. Degree of interest displayed by the students.
6. Extra curricular activities (science clubs, etc.)

List of the selected experimental schools should be prepared by the visiting group. Lists of each category of schools prepared by each group should be consolidated and three schools from the consolidated list for each category should be selected at random.

Step II. Evaluation of Selected Schools

In each selected school, all the sections of the experimental classes in any one or more science subjects should be evaluated.

In each school the representative sample will consist of :

a) three classes VI, VII and VIII

b) one, or more than one, section in each class

c) three or four subjects in each class

If one section is included in any one school there would be 11 subject groups.

The maximum number of sections in each subject to be assessed would be 54.

This sample would provide an accurate minimum assessment of the assimilated material by the students.

Step III. Implementations of the Plan

In 1968 it is proposed to evaluate mostly sixth and seventh classes and only partly eighth class. It is desirable that two co-ordinators be appointed or selected from the staff of DSE and DCE (one from each Department) as evaluators of the project as a whole.

These co-ordinators should look after the evaluation programme in all the subjects. In each subject one officer (a subject officer) should be made responsible for evaluation. If possible, a science counsellor from Delhi Directorate, a research assistant, or an experimental teacher should help the subject officer in administering tests and collecting data.

This would mean that each subject officer will have to evaluate, on average in the 1968-1969 school year, 4-5 schools each month covering about 18-20 sections. He should collect and analyse the following sets of data :

1. structured interview with teacher
2. test results from students.

Each subject officer should observe at least one lesson while visiting the school and prepare a report of his findings with respect to items No. 1 and 2 above.

For constructing all types of tests and interview forms, the officials of the Department of Curriculum and Evaluation should be requested to help the officers of the DSE. Also in this connection, workshops for the construction of tests should be organised in collaboration between two departments of NCERT - Science Education and Evaluation and Curriculum.

In addition to this, UNESCO experts should advise and supervise the evaluation programme in any one school and help in implementation of the evaluation programme.

G.R. Meyer, UNESCO Consultant
Dr. L.V. Levchuk, UNESCO Expert
K.S. Bhandari, Department of
Science Education

APPENDIX C

REPORT TO THE NCERT/UNESCO SECONDARY SCHOOL SCIENCE PROJECT ON THE BIOLOGY SYLLABUS FOR THE MIDDLE SCHOOL GRADES VI TO VIII

The construction of the biology course for the secondary school grades VI to XI is based on the principle of linear development. There are, however, some topics such as the cell, evolution and the anatomy and physiology of organ systems that have been developed in a spiral or concentric way, the topics being introduced in Middle Schools and treated again in a new way in High School.

The reason for the emphasis on linear development is understandable. The accepted view is that school courses in India, largely for economic reasons, must be compressed into as short a span as possible, while at the same time ultimately reaching standards comparable to those in Britain, Australia, U.S.S.R. and U.S.A. Repetition of material must, therefore, be cut to a minimum. The spiral or concentric approach usually adopted in the teaching of science in other countries is a luxury that India cannot afford.

There are however, some dangers in adhering too strictly to the principle of linear construction. The principle could lead, unless suitable precautions are taken, to the following shortcomings in the course of studies for the Middle Schools.

1. The basic knowledge of biology necessary for an understanding of generalizations and principles, is the diversity of plants and animals. Much emphasis must be given to this topic in the Middle School. This is the more traditional part of established courses of biology, usually taught as descriptive material and in a didactic manner. Great care must therefore be taken in programmes of teacher education to ensure that diversity is taught to emphasise general principles and the processes of modern biology. There is a grave danger that it will be taught as a series of isolated facts.

2. Because a linear programme does not fully achieve its objectives until the conclusion of its total programme, there is danger that a pupil in Middle School will not appreciate the reasons why it is necessary to study certain topics. There is some possibility that parts of the programme could appear unreal, unrelated to the needs of the pupil and generally academic in orientation. This could lead to a loss of interest in science with all that implies (e.g. poor learning and poor recruitment into senior courses). It also means that there

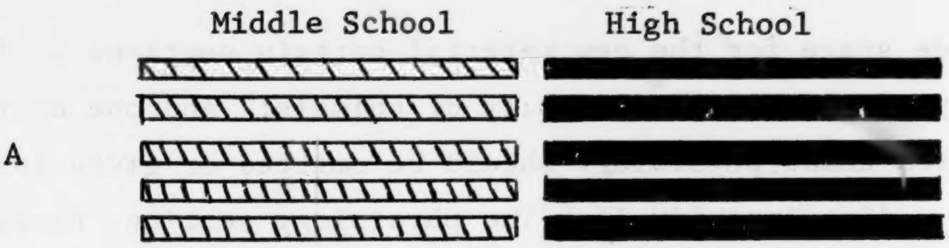
is some danger that pupils who leave school at grade VIII (and this is a high percentage) will never appreciate the reasons why they studied certain topics or performed certain tasks. Their education may not have much application in their every-day lives.

3. The concentric element in the programme does give some opportunity for pupils in Middle School to appreciate something of their relationships with the environment, but because of the linear structure, and because environmental studies are emphasised in High School, there is a danger that the following vital topics will not be given sufficient attention in the Middle School :-

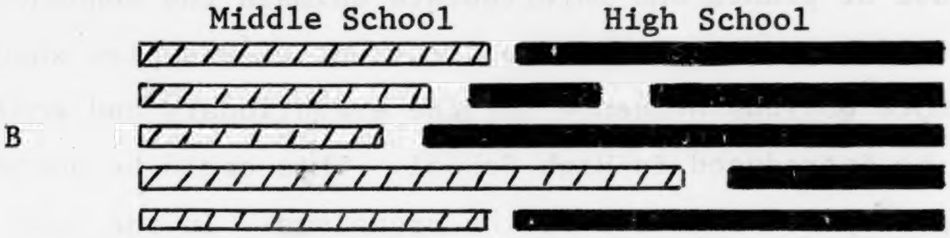
i. Adaptation to environment
ii. Sex and inheritance
iii. Inter-dependence of the living and non-living world
iv. Conservation

4. Care must be taken even in a linear sequence, to provide for an occasional section which draws together many of the principles emerging from the course. This is particularly necessary at the conclusion of class VIII where, for both terminal and continuing pupils, there should be a 'concluding section' drawing together the main ideas of the syllabus and indicating their significance in the every-day lives of the pupils. Absence of such a section could be a serious shortcoming.

5. In a linear programme of biology there could be a somewhat abrupt transition from the work of Middle School to the work of High School unless special care is taken to avoid this. Of necessity the work in Junior Classes is based on simple observation and experimentation. While this continues in High School, the work at the same time requires a much more sophisticated way of thinking. It emphasised generalisations, abstractions, concepts and theoretical models. Care should be taken to reduce the abruptness of the change by providing 'bridges' or 'natural links' between the Junior or Senior courses. Articulation can be of two types as shown by the following diagram.



Abrupt Transition at Grade VIII



Some Links and Bridges Between VIII and IX

In the diagrams each line represents the linear development of a central theme of biology. Bars shown ▨ represent essentially concrete experiences of observation and experiment, and bars shown ■ represent experiences depending largely on abstractions, generalisations and conceptual thinking.

The type of articulation shown in A should be avoided and that shown in B should be developed as far as possible.

GENERAL RECOMMENDATIONS

1. Because of the need to reduce overlap and repetition to a minimum, the principle of vertical rather than concentric construction of the syllabus should be retained.
2. The general framework and orientation of the syllabus should also be retained with some minor amendments aimed at reducing the possible shortcomings indicated above.
3. To provide a summary unit for the close of the course for Middle School, and to give a bridge between the materials and types of thinking of Middle and High School, the following topics should be included in the course for grade VIII.
    - i. Simple concepts of inheritance in man. Mendel's 3:1 and 9:3:3:1 ratios.
    - ii. A new 'summary' section called 'Man and his Environment' should be included at the end of the course. This section should give some understanding of the relationships between the living and the non-living world, a simple analysis of the biological events occurring in an agricultural field, and a general consideration of the way man should learn to control, manage and conserve the resources of his environment.

iii. To provide space for the new material certain sections of the diversity of plants and diversity of animals; and one or two topics from human physiology, should be omitted or given less emphasis. (See Appendix I). The physiology section, however, is in the main, excellent.

iv. In the case of plants and invertebrate animals the sequence by phyla should be retained but the treatment of examples should provide more obvious evidence for the evolutionary and ecological ideas to be introduced in High School. This could be achieved by stressing adaptive features of the organisms. In the case of the diversity of placental mammals the formal treatment by Orders should be abandoned and the examples grouped instead under adaptive headings, e.g. 'Flying Mammals'; 'Aquatic Mammal'; 'Forest Mammals'; 'Desert Mammals', etc.

The emphasis on the importance of various organisms to man is excellent and should be retained.

SPECIFIC RECOMMENDATIONS IN TERMS OF PERIODS

1. Reduction of diversity of plants and animals by at least 20 periods.
2. Reduction of human physiology by 5 periods.
3. Introduction of a new paragraph XA on page 42 - "Mans' Inheritance" - 5 periods.

   Principles of inheritance. 3:1 and 9:3:3:1 ratios.
   Some examples of human inheritance
4. Introduction of a new section following the present paragraph XI on page 42 -

   'Man and his Environment' 20 periods.
   Inter-dependence of the living and non-living 5 periods
   The biology of an agricultural field 10 periods
   The management and conservations of man's resources 5 periods

RECOMMENDATIONS FOR OMISSION OR REDUCTION OF SPECIFIC TOPICS

See Appendix I

RECOMMENDATIONS ON USE OF MICROSCOPE

See Appendix II

CURRICULUM GUIDE FOR THE PROPOSED NEW TOPIC ON MAN AND ENVIRONMENT

See Appendix III

DETAILED STATEMENT OF NEW TOPIC "MAN AND HIS ENVIRONMENT"

See Appendix IV

APPENDIX C (Cont/d.)

APPENDIX I

C_1. RECOMMENDATIONS FOR DELETION OR REDUCTION OF TOPICS IN THE SYLLABUS IN GRADES VI TO VIII

A. COMPLETE DELETION

type of stems p. 25
arrangements of leaf on stem p. 25
inflorescences p. 26
types of fruits p. 26
families of flowering plants pp. 27-28
horsetails, club-mosses and fossil pteridophytes p. 28
Paramecium p. 30
Cyclops and Daphnia p. 32
cockroach - internal structure p. 32
boney fish - internal parts p. 33
Calotes - internal anatomy p. 34
pigeon - internal anatomy p. 35
Orders of placental mammals p. 36
prevention of curvature of vertebral column and flat foot p. 38
effects of sport and liquor on the circulatory system p. 39

B. REDUCTION IN EMPHASIS

Note : As this is basically a matter of interpretation, evidence for the recommendations comes mainly from the texts. I suggest the syllabus itself be amended by making the notations indicated below in brackets.

Page	
23	cell division (concept only, no treatment of mitosis)
23	composition of air (brief mention only)
25	venation in leaves (mention function only not types)
26	vegetative reproduction (mention only potato, a sweet potato) and banana, (cuttings and grafting - briefly)
28	algae : Chlamydomonas, Spirogyra (simple structure but not life histories)
28	fungi : structure and general biology but not life cycles of Mucor, mushroom and Penicillium
28	lichens (briefly)

Page	
28	moss (briefly - no details of life cycle)
28	fern (briefly - no details of life cycle)
29	gymnosperms (briefly - no details of life cycle)
30	earthworm (as in syllabus but amend to read 'no details of reproductive system')
39	natural and artificial immunities (brief treatment)

APPENDIX C (Cont/d.)

APPENDIX II

C_2. RECOMMENDATION ON THE USE OF THE MICROSCOPE IN CLASS VI TO VIII BIOLOGY

Given an ideal educational system there is little question that every pupil in the lower forms of the secondary school should have an opportunity to learn to use the microscope for the observationof living things. Almost no school system in the world has attained this ideal.

There is, however, a number of arguments that have been put forward in many countries against introducing microscope work before the higher grades of the high school. Those arguments, translated in to the Indian context, could be summarised as follows :

1. A usable and worthwhile microscope is relatively expensive and money spent on this one instrument could buy a considerable stock of more versatile equipment. We must be careful not to buy instruments so cheap that they are just hand-lenses in fancy stands.
2. Microscopes are delicate precision instruments requiring considerable skill on the part of the users. They also require constant skilled maintenance and this is not usually available quickly and easily.
3. At best, State departments of education in India could probably place only one instrument in each Middle School. This would mean individual pupils could not effectively use the microscope. Microscope could only be used for demonstrations set up by the teacher. The use of the microscope for demonstration purposes has the following disadvantages :
    - i. The teachers can not be sure that each pupil sees and understands what he is expected to see and understand
    - ii. If many pupils use the one instrument, one after another, it continually goes out of focus or the slide moves on the stage. If moving objects are being studied, they frequently leave the field of observation. This means that the demonstration requires the constant undivided attention of the teacher. The teacher must also try to interpret for each pupil individually what each pupil is seeing while looking into the instrument.

iii. Each pupil in the queue gets little more than a glance down the eyepiece. If there are 30 children in a class each would have only 1 minute for his turn, there is thus no opportunity to observe slowly and in detail, and yet this is the only way that the observation can be interpreted.

iv. The interpretation of what is seen in a microscope requires considerable skill and absolute familiarity with the instrument. This comes only with regular use of the microscope; that is impossible if it is provided only for demonstrations.

v. Because the teacher must give full attention to each pupil in the queue in turn, the rest of the class is neglected. One period must be sacrificed in order to give each pupil one minute of observation, without any certainty that that observation will be meaningful.

4. Many syllabuses on analysis, reveal a very low frequency of use of the microscope. Sometimes the frequency is so low that there seems little justification for buying such an expensive and difficult instrument at all. Analysis of the syllabus for grades VI to VIII in India (UNESCO)/NCERT shows the following situation :

140 or more demonstrations, practical activities or field excursions are specified in the syllabus. Of these, only sixteen (12%) specify the use of the microscope. This list could be reduced to 5 only (1.4%) by the use of suitable visual aids. The five that remain are as follows :-

examination of
1. different forms of bacteria
2. pond scum
3. living protozoan
4. epithelium from the mouth
5. blood smear

Even these 5 could be replaced by alternative experiences - projector slides, charts, pictures or single concept 8 mm film loops. Admittedly those are poor substitutes for direct observation if the latter can be done well. It is, however, worth questioning whether the loss of this experience would seriously endanger attainment of the over-all objectives of the course.

RECOMMENDATIONS

A. First Preference. Microscope work should be omitted from classes V to VIII. All specifications for practical work should be amended to omit the use of this instrument and texts and related materials should be modified accordingly.

Alternative means of teaching the material should be substituted. Schools should purchase 35 mm slide projectors and make extensive use of slides of 35 mm photomicrographs. A projector is a more versatile instrument than a microscope, as it serves all subjects and almost all topics.

B. Second Preference. If the microscope work is retained it should be left as an option, with prevision for alternatives such as projector slides. Texts and other materials should be modified accordingly.

APPENDIX C (Cont/d.)

APPENDIX III

C_3. CURRICULUM GUIDE FOR THE PROPOSED NEW TOPIC ON MAN AND ENVIRONMENT FOR MIDDLE SCHOOL SYLLABUS IN BIOLOGY

MAN AND HIS ENVIRONMENT

I. Interdependence of the Living and the Non-Living

Pose the question that life has existed for thousands of millions of years, each generation using raw materials from the environment. Yet these resources have not been exhausted.

The answer to this apparent paradox is to be found in an understanding of the relationships between plants (producers) and animals (consumers). There is a cycle of life and death. Elements and simple compounds leave the non-living world at about the same rate as they return, maintaining a balance.

Elements and simple compounds that cycle between the living and non-living are water, carbon and oxygen, nitrogen and other inorganic chemicals such as salts, necessary for living things.

The source of energy for living things is the Sun. This energy does not flow in a cycle. There is a one-way flow of energy through living systems.

II. An Agricultural Field

An agricultural field is subjected to the changes of the environment that neighbouring areas must experience. There are periodic droughts and possibly floods. The quality of soil varies with both the climate and the nature of the parent rock. Soil consists of mineral particles, air and water plus materials produced by living organisms.

Soil supplies most of the raw materials for the living things of the field. Air is another resource, supplying oxygen and carbon dioxide. Energy flows in to the field from the Sun. The producers of the field are the plants. There are strata or layers. First there is the soil layer, then a thin layer of surface litter and finally the layer of living plant shoots. Each layer is a special kind of place different from each other layer.

The animals of the field live in the layers. In the soil itself many organisms such as the earthworms are adapted for burrowing and living in darkness. They contribute to the fertility of the soil. In the litter and in amongst the shoots many insects and other invertebrates are found. They are highly adapted to resist dryness and to live on the resources of the field. Many are potential pests for the crops, but all are important in providing food for carnivorous birds and other small vertebrates and also because they contribute to the fertility of the soil. The main danger of growing a single crop is that it makes a once varied place uniform and hence suitable for a particular species of insect which could become a pest.

Grazing mammals could be placed on the field by the farmer if the crop is suitable fodder. These animals are suitably adapted for grazing. Care must be taken to stock the field with the numbers of cattle that could be supported in a poor season. It is dangerous to stock only for a good season. The number of herbivores in the field is determined by the quantity of food (i.e. fodder). In a natural community or in a game park the number of grazing cattle are also partly controlled by the number of carnivores (e.g. tigers) that eat them. The balance of nature is such that there is more grass than grazing mammals and more grazing mammals than flesh eating mammals. Biologists call this the Pyramid of Biomass.

The cycles of water, carbon and oxygen, nitrogen and salts operate in the field ensuring a renewal of the resources for the crop. If the cycles are disturbed, however, such as by taking away the crop and not letting it return to the soil, or by trying to force too much growth for the resources (e.g. water) available, then unless suitable precautions are taken, the field may not function properly and could become useless to the farmer. Precautions must be taken to return resources to the non-living world. Fertilizers are one way of achieving this.

The whole system must be carefully controlled by the farmer. If the yield of the product is to be increased then he must understand how to improve the resources of the field by ensuring a most economical turn-over of the cycles.

III. Man and Conservation

Man utilizes many resources - some are renewable and some not renewable. Renewable resources are generally those from the living world - soil, forests and wildlife, for example.

Man must conserve his environment. Conservation means the proper management and use of resources. In the case of non-renewable resources, such as certain minerals, it means the application of our scientific knowledge to the development of suitable substitutes. In the case of renewable resources it means the establishment of a balance of harvest and renewal so there is a continuous yield.

Biological resources that must be conserved by man include soil, forests and wildlife. There is danger, too, that man will pollute his resources by pouring wastes in to rivers or in to the atmosphere. Another danger is that the careless use of powerful insecticides and other chemicals may disturb the balance of the natural cycles. Fortunately biologists are now aware of these dangers and are seeking ways of overcoming them. The final solution, however, rests with individual citizens who must be aware that in making certain unthinking changes in our environment they may cause other changes, the consequences of which they cannot foresee. By understanding and co-operating with the forces of his environment man will increase his control over them.

APPENDIX C (Cont/d.)

APPENDIX IV

C$_4$.

DETAILED STATEMENT OF NEW TOPIC "MAN AND HIS ENVIRONMENT" PROPOSED FOR MIDDLE SCHOOL SYLLABUS IN BIOLOGY

MAN AND HIS ENVIRONMENT — 20 periods

I. Interdependence of the living and non-living — 5 periods

The sun as the source of energy for living things. Food chains : plants (producers); animals (consumers); and bacteria (decomposers). Exchange of chemicals between the living and non-living world. Simple idea of cycles of water, oxygen and carbon and nitrogen. Man's place in the chemical cycles.

Demonstrations and Pupils Activities

(1) Study of a balanced freshwater aquarium containing water weeds, small fish and pond snails.

(2) Working out, by observation, some food chains which include man.

Field Work

(1) Study of the plants and animals of the school garden to work out which are producers and which are consumers.

II. An Agricultural Field — 10 periods

The sun as the source of energy for living things in the field. The environment in the field. Daily and seasonal changes in heat, moisture and light. Drought and flood. Animals and plants of the field. Adaptations of animals for living in soil and herb layers.

Role of insects and other invertebrates as (a) food for other animals - food chains, (b) potential pests and, (c) possible aids to the farmer - pollination, nutrition of soil, etc.

Grazing mammals (e.g. cow, goat, antelope). Dangers of overstocking. Place of grazing mammals in the food chains of the field. Influence of carnivorous mammals in natural communities. The pyramid of numbers.

Brief consideration of the chemical cycles (water, oxygen and carbon and nitrogen) in the field. Dangers of disturbing the cycles by total removal of crop, etc. Roles of fertilizers, rotation of crops, contour ploughing, fallow periods, and proper crop and herd arrangement.

Field Work

(1) Study of the plants and animals of an agricultural field to study their adaptations.

(2) Working out of typical food chains in the field.

(3) Study of the methods used by the farmer to conserve his field and produce the maximum yield.

III. Man and the Conservation of Nature — 5 periods

The need to conserve biological resources - soil, plants and wildlife. Methods of conservation. Methods of preventing pollution of air and water. Dangers of careless use of pesticides in disturbing the balance of nature. Responsibility of every citizen to practice conservation.

Field Work

(1) Visit to a Game Park and National Forest to study methods used for the conservation of wildlife, trees and soil.

(2) Comparisons between neglected farms, erosion and well managed farms.

(3) Planting of trees and shrubs in the school grounds and in suitable places in the community.

APPENDIX D

REPORT TO PROFESSOR S.A. BALEZIN, DR. M.C. PANT, AND THE UNESCO/NCERT BIOLOGY SYLLABUS COMMITTEE ON BIOLOGY BOOKS PARTS I, II AND III PRODUCED FOR INDIAN MIDDLE SCHOOLS

In this report, comments are not included in the over-all structure of the programme, on the selection of topics or on the proportions of time allocated to each topic. Nor is the philosophy of the course - its objectives and criteria - considered. These aspects of the books result from characteristics of the syllabus for Middle School - and these characteristics have been discussed in detail in a separate report.

1.0 Practical Work

An excellent feature of the books is the close integration between theory and practical work. Almost all new topics begin with either observations or experiments and this is consistent with the best teaching method. The practical work is not presented in the form of the open-ended enquiry that is the fashionable trend in programmes such as B.S.C.S. (U.S.A.) and Nuffield (U.K.). Most of the work is to check on described structures or to verify stated laws or principles. This emphasis is probably deliberate. Open-ended enquiry requires a sophisticated level of teaching and a practical resource in the schools that is possibly unrealistic at this stage of development in Indian schools. Nevertheless some experience should be given in the solution of open-ended problems and it is recommended that about ten such experiences should be given each year in the form of projects. These projects should require pupils to investigate specified problems to which the answer is not known to either pupil or teacher.

2.0 Style of English

For pupils aged 9, 10 or 11 the English style must be very simple. Technical terms should be reduced to a minimum, long words should be replaced by short words wherever possible and sentences should be short.

In this regard Part I is most successful, Part II less successful and Part III least successful.

For example, the following extract from Part III, page 98, is probably too formal :

"The curves of the vertebral column easily change in the course of time, depending on the posture of the body. Thus a bent-over position will greatly intensify the thoracic curve and diminish the lumbar curve. If the posture of the body is such that the trunk is inclined to one side, a side curve will appear and prolonged maintenance of the body in an incorrect posture will produce habitual abnormal curves of the column, which will gradually become more and more fixed and remain through the life."

It could be simplified, perhaps, somewhat along the following lines:

"The curves of the backbone change according to the way we sit and stand. If we crouch, or walk with a stooped back, then the backbone curves in an unhealthy way. At the back of the chest the curve is made larger. In the lower part of the back the bones are squeezed together. If we carry a heavy load in one hand the backbone curves to one side. There is danger that if we sit or walk in these ways as a matter of habit, the backbone may become set and fixed in an incorrect position. This could give a mis-shapen body, clumsy and awkward movements and disorders of the muscles and nerves."

Whenever possible a concept should be introduced through some experience known to the pupil. For example in the section on snakes (p. 133 Part II) the idea of using experiences familiar to children has been recognised but not as the introduction to the section. The reference to the snake charmer should be used to introduce the topic of snakes.

On the whole, though, the style requires only minor modification.

3.0 Summaries

The summaries at intervals throughout the book are useful and should be retained.

It is recommended, however, that they be printed in a different type - italics or bold, to make them stand out and prevent their confusion with the main text.

4.0 Illustrations

1. The number of illustrations is adequate and most are necessary and relevant.
2. The quality of the art work is uneven. Some illustrations show excessive detail (e.g. figure 4.8 Part I) while others are simple outline drawings (such as figure 4.7 Part I). Some are too dark with too much shading (e.g. figure 5.1 Part I).
3. Most illustrations are of the correct size but some (e.g. figure 6.14 Part I) are too small.

4. At present the illustrations are well spaced and located in suitable positions with regard to the text.
5. Labelling, in general, needs considerable improvement.
    - i) Some diagrams (a minority) give too much detail in the labels (e.g. figure 5.5 Part II)
    - ii) Some diagrams have inadequate labelling, insufficient to explain structure (e.g. figure 8.3 Part I).
    - iii) Some diagrams have not been labelled at all and serve little function in the text (e.g. figure 7.1 Part II).
    - iv) N.B. The "Key" system of labelling used throughout is not satisfactory as it creates an unnecessary intermediate step (i.e. decoding the key) between the learner and the material he is to learn. Labels should be printed beside the structure or feature to which they refer. This is a most important and serious criticism.
6. Many captions are too brief.

7. A more serious criticism is that the text does not refer specifically to the illustrations in all cases.

Recommendations

1. The style of drawing should be standardised in two forms :
    - (a) all diagrams that pupils should know and be able to reproduce should be in the form of simple drawings without shading. They should be easy to copy and reproduce from memory.
    - (b) those diagrams included for background, general interest or enrichment, and which are not intended to be learnt and reproduced by pupils as part of their basic study programme, should be presented more artistically with shading and a three-dimensional style.
2. Labelling should change from the "key" system to the "direct label" system. Each illustration should be adequately labelled consistent with text.
4. In some instances captions could be expanded to give clearer explanations, e.g. figure 1.17 Part I 'sporangium of the fern' could be changed to 'a ripe sporangium of a fern bursts open to release its spores'.

5.0 Questions at the End of Chapters

The questions at the end of each chapter have three shortcomings.

In the first place, most require only the recall of specific facts. Tests of understanding are lacking.

Secondly, each set does not provide a complete review of the material in the relevant chapter. The number of questions provided is generally inadequate.

A third, most serious shortcoming, is that the questions have not been dealt with adequately in the Teachers' Guide. There is no discussion in the Guide of the overall purpose of the questions (review, discussion, motivation, a preparation for new work?), and even more seriously, answers have not been provided. Experience with the production of materials in Australia and U.S.A., has shown that unless clear unambiguous answers are provided in the Teacher's Guide to questions asked in the text, then the questions are avoided by the majority of teachers.

There are, however, some good features of the questions. The style is simple, direct and generally lacking in ambiguity. The relevance of the questions to the content of the chapter is immediately obvious and the answers require only simple and unambiguous answers from the pupils.

Recommendations

1. The questions should be considerably increased in number.
2. Questions should be grouped into three sets for each chapter.
   A. A set of factual recall questions, the answers to which would provide a reasonable summary of the main concepts and principles of the chapter. Those questions would require only short answers - one word, a short phrase, a short sentence or a simple diagram.
   B. Some 'thought' questions, requiring not only recall of facts, but also understanding, should be included. These should require either the analyses or evaluation of data or the synthesis of information.
   C. Two or three speculative questions as the basis of either class discussion or essay work.
3. The answers to all questions should be provided in the Teachers Guide.

6.0 Study Guide

The teaching notes, statements of objectives and descriptions of experiments given in the study guide (only No. 1 published so far 1.11.68) are excellent.

The main weakness of the study guide is that it does not include a general statement of the philosophy of the course, including the relationship of the Middle School course to the course for the Higher Secondary School. Another weakness is the fact that questions asked in the text have not been answered in the Teachers' Guide.

APPENDIX E

REPORT OF A RESEARCH STUDY ON THE ACCEPTABILITY OF THE NCERT/UNESCO CLASS VI BIOLOGY FOR CLASS V IN AN ENGLISH MEDIUM SCHOOL IN DELHI

For about four months during 1968 the Department of Science Education of NCERT conducted an experiment in its Demonstration School to see if the biology texts and materials produced by the NCERT in association with UNESCO for class VI could be successfully introduced into class V. This paper is a report of the investigation.

The Need

The biology texts used in the experiment (1) are the outcome of research conducted to improve science teaching in the middle stage in Indian schools. This programme envisages the teaching of science in separate disciplines of biology, physics and chemistry, as against the previous practice of teaching general science at this level. These materials were previously tried out for classes VI in some selected schools in Delhi.

When these materials were first produced a most common pattern in Indian schools was to have five classes in Primary School and two or three in Middle School. Textbooks were produced, therefore, mainly for classes VI, VII and VIII. (2) Since the publication of the materials, however, the Education Commission (3) has recommended that Primary School should consist of classes I to IV and Middle School of classes V, VI and VII.

The question therefore arises - can the materials originally written for, say, class VI be brought down with or without adaptation, for use in class V? In order to collect some evidence that would help answer this question the experiment reported here was undertaken.

The Design of the Experiment

NCERT had requested its Demonstration School, the Mother's School, Aurobindo Marg, New Delhi-16, to teach the NCERT/UNESCO biology course for class VI (Book I) both in class V sections A and B, and class VI sections A and B during the 1968/1969 academic year. The Mother's School is a Public (Independent) English-Medium School. To give guidance to the school in the first stages of implementing the new course, a biology teacher from the staff of NCERT taught class VB for the first twelve weeks of the term. 5A, 6A and 6B, during this period, were taught by a second teacher who was the regular biology teacher of the school. Both teachers were women and both had graduate training in biology and experience in teaching.

After twelve weeks it was shown that there were significant differences between achievement of understanding in class V and VI but none between 5A and 5B. (See results). The design of the experiment, therefore, was changed since the different teachers in 5A and 5B had not caused significant differences in achievement. The NCERT teacher was withdrawn leaving all four sections to be taught by the regular class teacher.

The experiment was thus in two stages :

Stage I : twelve weeks with both visiting and regular teachers
Stage II : four weeks with only the regular teacher.

The experiment involved the numbers of pupils as shown in Table I.

Table I. The numbers of boys and girls in four sections : 5A, 5B, 6A and 6B of the Mother's School

Sex	5A	5B	6A	6B
Boys	18	19	23	17
Girls	16	15	4	10
Totals	34	34	27	27

The sexes, therefore, were reasonably represented in all sections except 6A which had a majority of boys.

The average ages of the pupils in each section were as follows :

Section	Average Age
5A	10 years 6 months
5B	10 years 3 months
6A	11 years 6 months
6B	11 years 9 months

All pupils of all sections had approximately the same middle class to upper middle class socio-economic background. The two sections of each class were divided alphabetically and were not streamed by ability. Allowing for differences in age between class VI and class V there were no significant differences between the sections in intelligence or general academic achievement. Classroom climate, disciplinary tone and general attitude to school, at least in so far as these could be assessed by direct observations of lessons, were much the same from section to section, again allowing for age differences between classes V and VI.

Achievement tests were administered, and other measurements and assesments made to compare the acceptability of the materials in the two classes. (See methods).

It was recognised that the study would need to be interpreted cautiously if used as the basis for any generalisations about the acceptability of the materials for pupils other than those from middle to upper class homes.

Methods

During the first six weeks of the term an UNESCO expert regularly observed lessons in section 5B for comparisons with standards of achievement obtained by sixth class pupils in the 30 experimental schools of the UNESCO/NCERT project. The impressions of the expert were recorded by means of a written report and on interview.

After the conclusion of these initial observations the following methods were employed to collect more systematic data :

1. During both stage I and stage II systematic observations were made of classroom lessons by one, and sometimes two, observers. From these observations, ratings were made on 5 point scales for achievement of objectives in each section. Cognitive, affective and psychomotor factors were rated in this way. It was found that there was a high level of agreement between observers.

2. The regular class teacher was asked to make a self-rating of her degree of success in using certain teaching techniques recommended in the appropriate NCERT Teacher's Guide (4). Separate ratings were made for class V and class VI. This was completed at the end of stage II.

3. At the conclusion of stage I the results of the monthly biology test set by the school were analysed. This tested only specific facts that could be recalled by the pupils.

4. At the conclusion of stage I, an objective test of ten items was administered. This measured achievement in understanding concepts and principles taught during the previous four weeks. This was administered only to 5A, 5B and 6A.

5. A second objective test of 14 items testing understanding in science was administered to all four sections four weeks after the beginning of stage II. It covered the concepts and principles introduced during the previous six weeks.

6. A largely qualitative interest/attitude questionnaire was completed by all pupils four weeks after the beginning of stage II.

7. The regular biology teacher prepared a written report of her impressions of similarities and differences between classes V and VI. This was completed four weeks after the beginning of stage II.

Results

Achievement of Specified Objectives : Seven cognitive, seven affective and seven psychomotor objectives (Table II) derived from analysis of the syllabus (4) and texts, were studied by direct observation of classroom lessons. The degree of achievement of each objective was rated by the observers. Ratings were established for classes as a whole with the aid of verbal equivalents and against what would be regarded as the possible distribution of these ratings in a random group of 5th and 6th classes in representative schools in Delhi. Sufficient lessons were observed by two raters simultaneously to establish a high level of agreement between observers and to give confidence in the reliability of the method.

No significant differences could be established between section A and B within each class, so the result from these sections were combined. A measure of the degree of achievement of each category of objectives was obtained by expressing the total average rating for each category, i.e. cognitive, affective and psychomotor, as a percentage of 35 - the total possible rating for the category. These results are summarised in Table II.

Table II. Average ratings (scale 1-5) on the achievement of selected educational objectives in class V and class VI.

Objective	Degree of Achievement (Average Rating) 5 High to 1 Low	
	Class V	Class VI
I. Cognitive		
1. Knowledge of facts in text	3	4
2. Understanding of facts in text	2	3
3. Response to questions	2	3
4. Knowledge of facts of experiment	3	4
5. Understanding of principle of experiment	3	3
6. Understanding conclusions from the experiment	1	2
7. Ability to reach independent conclusions	1	3
Total and % Cognitive	15 (43%)	22 (63%)
II. Affective		
8. Interest during introduction to lesson	3	3
9. Interest during the main part of lesson	3	3
10. Interest during conclusion of the lesson	2	2
11. Interest in demonstration experiments	4	4
12. Interest in experiments performed by pupils	5	5
13. General attitude to biology lessons	4	4
14. General scientific attitude	1	1
Total and % Affective	22 (63%)	22 (63%)
III. Psychomotor		
15. Making biological drawings	2	4
16. Handling glassware	3	4
17. Handling dissection instruments	4	4
18. Handling biological specimens	3	4
19. Handling measuring instruments	3	4
20 Using a lens	3	4
21. Using a microscope	1	2
Total and % Psychomotor	19 (54%)	26 (74%)

Use of Preferred Methods of Teaching : Four related continua of teaching procedures were identified from analysis of the text and Teachers' Guide as being significant in the implementation of the new course. Each continuum was scaled from zero (the maximum use of the least desirable method) to 100 (maximum use of the most desirable method). The four continua were as follows :

1. Verification (0) to problem-solving (100)
2. Teacher activity (0) to pupil activity (100)
3. Use of blackboard (0) to use of objects and materials (100)
4. Use of demonstration experiments (0) to experimentation by pupils (100)

The regular class teacher was asked to mark on a percentage rating scale, an estimate of her position on each continuum for class V and class VI. These self-ratings were then validated by observations of her lessons by independent raters. The results were calculated as ratios of time spent on most desirable methods to time spent on least desirable methods expressed as percentages - see Table III.

Table III. Percentage use of desirable methods of teaching in classes V and VI based on self-ratings of the class teacher

Teaching Methods (shown as ratios of desirable to undesirable)	Percentage use of Desirable Method	
	Class V	Class VI
1. Problem solving Verification	55	66
2. Pupil active Teacher active	30	70
3. Use of objects and materials Use of blackboard	50	50
4. Pupils do experiments Demonstration experiments	30	60

Attainment of Factual Knowledge : At the conclusion of stage I of the experiment the school administered a standardised achievement test in biology on work given to all four sections. This tested only factual recall of knowledge and not higher cognitive objectives. As such it provided a good opportunity to compare the abilities of the two classes simply to acquire knowledge of the new course. No significant differences were found between sections within each class so the results of these sections were combined. Data comparing class V and class VI are shown in Table IV.

Table IV. Comparisons between class V and VI on a standardised test of biological knowledge. Raw scores scaled from 0 to 100.

Class	N	Mean ± S.E.	Standard Deviation	Critical Ratio	Significance of Difference between Means
V	65	31.8 ± 6.8	55.3	1.30	n.s.
VI	50	43.4 ± 7.3	51.3		

Attainment of Understanding : An especially constructed test of achievement of knowledge, comprehension, application, analysis and evaluation as defined by Bloom (5) was administered towards the end of stage I. The test consisted of 10 multiple choice items carefully selected to test achievement in both knowledge and understanding of major concepts taught during the previous four weeks. Unfortunately, for administrative reasons within the school, it was not possible to give this test to section A of class VI. The results for sections 5A and 5B are shown in Table V.

Table V. Comparisons between sections 5A and 5B on a standardised test of biological knowledge and understanding. Test I at the end of stage I. Raw scores from 0 to 10.

Section	Teacher	N	Mean ± S.E.	Standard Deviation	Critical Ratio	Significance of Difference between Means
VA	Regular	30	3.3 ± 0.5	2.6	1.37	n.s.
VB	NCERT staff	34	4.0 ± 0.7	4.1		

Incidentally, the interesting result that there was no significant difference between sections 5A and 5B on this test in spite of their being gaught by different teachers, together with evidence from observations of lessons, showed that the two sections formed a reasonably homogeneous group. It was on this basis that the NCERT staff teacher was withdrawn and the experiment entered phase II. Results from the two sections of fifth class were pooled for comparison with sixth class (VIB). The results of this comparison are shown in Table VI.

Table VI. Comparisons between classes V and VI (VIB only) on a standardised test of biological knowledge and understanding. Test I at the end of stage I. Raw scores from 0 to 10.

Class	N	Mean ± S.E.	Standard Deviation	Critical Ratio	Significance of Difference between Means
V	64	3.9 ± 0.6	5.1	2.59	0.01
VI (B only)	21	6.1 ± 0.6	2.8		

To enable the change-over from the experimental to the regular teacher to stabilise, and to allow for more concepts to be covered, no achievement testing was undertaken for a further four weeks. At this time a second multiple choice achievement test of biological knowledge and understanding was administered. This consisted of fourteen items testing concepts taught during the previous six weeks. No significant differences were found between the two sections within fifth class or the two sections within sixth class, so results within classes were pooled and comparisons made between total class V and total class VI. The result of this latter comparison is shown in Table VII.

Table VII. Comparison between classes V and VI on a standardised test of biological knowledge and understanding. Test II at the end of stage II. Raw scores from 0 to 14.

Class	N	Mean ± S.E.	Standard Deviation	Critical Ratio	Significance of Difference between Means
V	54	4.90 ± 0.62	4.59	2.55	0.02
VI	41	8.07 ± 1.12	7.20		

Certain key questions in test I and test II were subjected to detailed item analysis. These analyses revealed the following trends :

1. There were no significant differences between classes V and VI in the acquisition of knowledge provided the teacher had given equal stress to the topic tested and used the same methods in the two classes.

2. Where the teacher had given more stress in one class than another to practical activity by the pupils, that class with most stress on activity had better knowledge and understanding than the other class.

3. Both classes had some difficulty in understanding the logical steps necessary to reach a conclusion from experimental data but this was significantly more unsatisfactory in class V than class VI. For example, a 'comprehension' question based on the simple steps of the following argument was answered correctly by only 28% of class VI and 17% of class V :

   "Starch turns blue with iodine
   Seeds turn blue with iodine
   Therefore seeds contain starch".

4. Both classes had some difficulty in grasping the significance of a control in biological experiments but again this was significantly more unsatisfactory in V than VI. For example, the following difficult question on the significance of controls was answered correctly by 32% of class VI but only 23% of class V.

   "We have three test tubes labelled I, II and III each containing seeds :-
   I. contains dry seeds
   II. contains soaked seeds
   III. contains seeds under deep water.

   To show that air is necessary for germination we should need to look at -
   A. all three tubes
   B. tubes I and II only
   C. tubes II and III only
   D. tubes I and III only
   E. only one of the tubes".

When this concept of control was tested by the following simpler item, the difference between class V and class VI was even more significant. In this instance the question was answered correctly by 80% of class VI but only 31% of class V.

> "We can conclude that living seeds give out carbon dioxide because -
>
> A. when we breathe into water it does not change colour
> B. breathing into lime water makes it milky white
> C. gas from seeds makes lime water milky white
> D. both A. and B.
> E. both B. and C."

5. Class V had significantly less ability than class VI in applying concepts introduced in one context, to the solution of problems in another context.

6. Certain topics such as the structure and functions of the cell caused more difficulty with class V than class VI.

Attitude and Interest of Pupils : Towards the end of stage II all pupils completed a questionnaire requesting them to vote on their opinion of the degree of difficulty of the course, and on their level of interest. They were also given open-ended questions asking them to say what they liked most and least about the biology course. For the voting, 3 or 5 point scales were used with careful verbal equivalents, and all votes and statements were based on comparisons with most other subjects studied during the current academic year. Table VIII gives votes on impressions of the degree of difficulty of the course. Table IX gives votes on the degree of interest.

Table VIII. Percentage of pupils in classes V and VI voting on their impression of the degree of difficulty of biology compared with most other subjects studied during the current year.

Difficulty compared with most other subjects	Percentage of Pupils	
	Class V	Class VI
Hard	12	10
Much the same	50	20
Easy	38	70

Table IX. Percentages of pupils in classes V and VI voting on their level of interest in biology compared with most other subjects studied during the current year.

Interest compared with interest in most other subjects	Percentage of Pupils	
	Class V	Class VI
Very interesting	47	37
Interesting	26	26
Of average interest	9	22
Boring	9	5
Very boring	9	10

Those aspects of the course liked least and those liked most were extracted from a content analysis of replies to open-ended questions. The statements were grouped into categories and the frequency of mention of each category calculated separately for class V and VI. These comparisons are given in Table X.

Table X. Frequency of mention in classes V and VI of aspects of the biology course least liked and most liked. In class V $N_1 = 54$, in class VI $N_2 = 38$

A. Aspects most liked	Frequency of Mention	
	In class V (% N_1)	In class VI (% N_2)
Performing experiments	61	61
Interested in plants and animals in nature	39	42
Using the microscope	19	3
A vocational interest	9	0
Drawing diagrams	7	13
Field work	6	0
Teacher's method of teaching	0	13
Interest in specific topics	63	33
B. Aspects least liked	**Frequency of Mention**	
	In class V (% N_1)	In class VI (% N_2)
Performing experiments	13	3
Drawing diagrams	11	0
Field work	4	0
Using the microscope	4	11
Hard to understand	4	13
Too many notes to write	2	13
Dislike of specific topics	27	16

Report by the Class Teacher : The class teacher was asked, at the conclusion of Part II, to write down her impressions of the acceptability of the course in class V as compared with class VI. She mentioned the following nine points.

1. Class VI children were able to grasp the subject matter quicker than the class V children.
2. The teacher had to spend more time explaining to class V in order to convince them of something.
3. Class V children were not able to arrive at conclusions by themselves as readily as the children of class VI.
4. Class V children easily get confused between technical terms. It was not always possible to avoid technical terms, e.g. Cotyledon, cytoplasm or vacuole. For some children of class V cytoplasm became confused with Cotyledon and vacuole was thought to be part of the seed.

5. The spelling, especially of technical terms, was better in class VI than class V.

6. Most of the VI class children could draw neat and well labelled diagrams but only a few in V class could do this.

7. Class VI children could take down short notes in the class while listening to the teacher, while in fifth class this was practically impossible.

8. In VI class, since there were practical periods (double periods) the children got chances of handling the microscope and also of doing some of the experiments by themselves, whereas in V class they did not get a chance to handle the microscope themselves. So the VI class children could use the microscope somewhat skillfully, whereas in V class, no such skill was developed.

9. In spite of all these drawbacks, I found that the V class children took more interest in the subject. For example, the V class children were more enthusiastic about growing seedlings themselves or about bringing necessary materials to the class.

Impressions of UNESCO Expert : After six weeks of observation of lessons in class VB a UNESCO expert who had monitored the experimental course in 6th forms in other schools, gave his impressions of the comparative standards. He considered that there was little difference between class V and class VI in achievement of knowledge, but that the Vth class pupils lacked self-discipline and were not as conscientious about home tasks as pupils in class VI.

Discussion

The imperfections of the various rating and testing methods used in this study are well known. But in spite of these, highly consistent results were obtained for related aspects of the problem using different techniques such as observer ratings, self-ratings, tests, opinion polls or qualitative reports. It was possible to arrive, therefore, at a reasonably valid answer to our question on the acceptablity of the course for class V.

In the first place we note the over-all high levels of interest in both class V and class VI (see Tables II and IX). There was no significant difference between classes. It was especially pleasing that over 60% of both classes enjoyed the course and less than 20% were bored by it. The high level of interest in practical experiments performed by pupils themselves is especially important for teachers to understand. Teachers should note, too, the decline of interest towards the close of the average lesson. Perhaps too much material is being crowded into the lesson time.

Aspects most liked or disliked showed very little variations from class V to class VI (Table X). Teachers should note, however, that pupils at this level often have a basic interest in plants and animals and in nature that should be made use of in the classroom. The low frequency of mention of unpopular aspects supports findings from the opinion poll and from observation of lessons.

It was also a source of satisfaction that only about 10% of pupils in each class found the course harder than most other subjects (Table VII).

The fact though, that only about 40% of V compared with some 70% of VI considered it easier than most other subjects, is related to the differences between these classes in cognitive achievement (Tables VI and VIII). This aspect is discussed later.

Differences between the classes in psychomotor abilities are noted (see Table II). These are due to differences between the levels of physical maturity of the pupils and also to different arrangements for teaching practical work in the two classes. The absence of double periods for class V is a most serious disadvantage. Teachers should understand and cater for the obvious lack of physical skill in class V compared with class VI. They should provide plenty of opportunity for younger pupils to handle equipment and perform experiments for themselves. Given suitable methods of teaching this finding should not be a barrier to the acceptability of the course in class V.

In the area of cognitive achievement it was found, contrary to expectation, that both classes had much the same capacity to remember and recall the facts taught over a period of about four weeks. This was a most encouraging finding since, of course, understanding of main cognitive objectives only comes if facts are known.

The highly significant differences between the two classes in attainment of higher cognitive objectives is of major concern. The finding that both classes have difficulty in understanding the logic of the scientific process should alert teachers to pay special attention to this problem. That this difficulty is greater in class V than class VI becomes the central issue in the question of the acceptability of the course for that class.

If the course is to be used in class V, certain adaptations and modifications of the VI class materials would seem essential. The kinds of modifications required are set out below (Recommendations).

Finally, we must return to the qualifications made at the beginning of this paper. Our study was limited to one school with pupils of a particular socio-economic grouping. Generalisations about acceptability of the materials in the V class of other types of schools should be made cautiously.

Recommendations

1. Books I, II and III designed originally for classes VI, VII and VIII could be reduced in content by approximately 20%.

2. The style of the language used in all these books, but especially in II and III, could be simplified.

3. Greater care should be taken in explaining the steps of logical reasoning used in science, e.g. how it is possible to draw conclusions from observations or experiment.

4. Book I, originally written for class VI, should have two editions. (A) for pupils who would begin the course in class VI. Provided the minor modifications suggested in 1., 2., and 3. were made, the materials for this edition would be satisfactory in their present form. (B) for pupils who would begin the course in class V. In this edition the factual content would need

to be cut by about 30%. In place of this a great deal more attention would need to be given to explanations of scientific reasoning, e.g. why a control is necessary and how to draw conclusions from data.

If the last recommendation were adopted it would, hopefully, cater for the differences between class V and VI revealed by this study. It would, in all probability, allow pupils beginning the course in Vth class and pupils beginning the course in VIth class to reach approximately the same levels of understanding of concepts and processes after one year. Both groups should then be able to continue with a common edition of Book II in either class VI or class VII.

In addition, it is strongly suggested that the weaknesses in the achievement of psychomotor and certain cognitive objectives as shown in this study, could be overcome only by giving adequate opportunity for practical work. It is most important that both class V and VI (but especially class V) have a least one double period each week for practical biology and that the single periods contain as much practical activity as possible.

Acknowledgements

The authors wish to thank Dr. M.C. Pant, Head of the NCERT Department of Science Education, and Dr. S.A. Balezin, Chief of Mission UNESCO Secondary School Science Teaching Project, for helpful discussions and advice. We are especially grateful to the Principal Mr. M.P. Chhya, staff and pupils of the Mother's School for their helpful and willing co-operation. In this regard the class teacher Mrs. M. Pathrose should be given our special thanks. Dr. V.I. Galakhov, UNESCO Expert, gave us much useful information on his impressions of differences between classes V and VI, and we are most grateful to him.

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1. National Council of Educational Research and Training :
   Biology Part I Science for Middle Schools
   Biology Part I Science for Middle Schools - Teacher's Guide
   Biology Part I Science for Middle Schools - Curriculum Guide. New Delhi. NCERT Publication Unit, 1967.

2. National Council of Educational Research and Training :
   See 1. In addition -
   Biology Part II Science for Middle Schools
   Biology Part III Science for Middle Schools
   Pilot Editions, New Delhi. NCERT Publication Unit, 1968.

3. Education Commission, 1964-66, Report of. Summary of Recommendations. New Delhi. NCERT Publication Unit. 45-48. 1967.

4. National Council of Educational Research and Training : An Experimental Project for the Improvement of Science Education in Schools. Syllabus of Science and Mathematics for the Middle School Level. New Delhi. Department of Science Education, NCERT. 21-42. 1967.

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Miss S. Mazumdar
Dr. G.R. Meyer

23.11.1968

APPENDIX F

REPORT TO THE NCERT/UNESCO SECONDARY SCHOOL SCIENCE PROJECT ON THE BIOLOGY SYLLABUS FOR HIGH SCHOOL GRADES IX TO XI

This proposed syllabus has taken into consideration trends in the teaching of biology in countries such as Britain, Australia, U.S.A. and U.S.S.R. These trends include an emphasis on concepts and generalizations, on scientific enquiry and on recent biological discoveries. Courses too, are becoming more concerned with the applications of biology to everyday life.

Almost all modern courses of biology stress certain central concepts that explain diverse phenomena. These include the following ideas.

1. Living matter is organised on three levels - the cell, the organism and the population.
2. An organism works as an integrated whole in response to internal and external stimuli.
3. The chemical reactions of living materials are controlled by the nucleus of the cell through systems of enzymes produced by DNA.
4. The genetic code contained in DNA provides a 'blue-print' for producing the next generation.
5. There is a continuous cycling of chemicals between the living and the non-living world and a one-way flow of energy through living systems.
6. Changes in the distribution and abundance of organisms can be explained in terms of the interaction of components of their environment influencing birth rate and death rate.
7. Specialized organisms have evolved from more primitive organisms by the process of natural selection.
8. Adaptation is the end product of the evolutionary process. Diversity can be explained in terms of adaptive evolution.

In the draft of the present syllabus these trends and emphases have been adapted to the particular needs of the Indian educational system.

There is, however, a number of lessons learnt in U.S.A., Britain and Australia in regard to the implementation of a course of this type, and the following recommendations have taken this into consideration.

(8)

RECOMMENDATIONS ON THE IMPLEMENTATION OF THE COURSE

In preparing texts, teachers' manuals, practical work and courses for teacher education it is suggested that the following points be given some attention.

Section of Syllabus				Recommendation
Part IV	1.	I.	Introduction to General Biology	The role of biology in the economic development of India should be stressed. Care should be taken, also, to show that the methods of biology are useful to the scientists, but at the same time have application in the solution of problems of everyday life.
		II.	Levels of Biological Organisation	Different courses in different countries give different emphasis to the three levels of organisation - cell, organism and population. Because of the conceptual difficulties of teaching detailed cell biology, and because of the urgency of the need for Indian pupils to appreciate the principles of population ecology, it is suggested that least emphasis be given to the details of molecular biology and most to the biology of populations.
	2.		The Organism	The stress in parts I to III (for Middle School) has been on the biology of the whole organism. There has been a systematic survey of plants and animals with considerable attention to the general structural physiology of the flowering plant and the mammal. In implementing the section of the high school syllabus, therefore, perhaps only two or three topics need be

selected. They would, however, need to be studied in some detail.

Suitable topics would be -

i. reproduction and growth
ii. functions of nerves and hormones
iii. behaviour of animals
iv. biology of micro-organisms
v. metabolism of green plants

The main purpose would be to pursue in depth topics that would take pupils to the frontiers of present biological knowledge. The teaching should stress current problems of research, indicating the difficulties and methods of the research worker, and it should encourage speculation about the causes of unexplained phenomena.

3. Natural Communities

This topic has proved to be most popular and successful in courses overseas provided it is taught with suitable field and laboratory studies.

I. Populations

Care should be taken to precisely define terms such as distribution, survival, multiplication, environment, and rate of increase in numbers as used by population ecologists.

The analysis of the environment into abiotic and biotic factor is less useful than the following categorization (see Andrewartha and Birch 'Distribution and Abundance of Animals' U. of C. Press):-

(1) Weather : temperature
moisture
light
acidity etc.

(2) Resources : food
building materials
shelter
(both quantity and quality)

(3) Members of same species :
under population
crowding

(4) Members of other species :
mutualists
predators
disease
non-predators sharing
some resource etc.

(5) Hazards

Appropriate case studies of changes of populations in India should be studied, including man.

II. Communities

Probably the most suitable communities for study are the seashore, an agricultural field, a leaf litter community of a forest, or a pond or stream. Laboratory studies can be made of the organisms collected on field excursions, and in the field assessments should be made of appropriate components of environment. In the laboratory more refined studies can be made of these components, e.g. water and soil analyses.

III. Biosphere

The concepts of chemical cycles and the flow of energy emerge easily from the field studies of the previous section. It is recommended that studies be made of the turnover of the cycles in artificially maintained leaf litter communities or water cultures.

	IV.	Conservation	Care should be taken to consider conservation in the light of proper management of resources. The treatment should be such as to appeal to both the emotions and scientific understanding of pupils. Where possible the ecological aspects of conservation should be stressed. Extensive use should be made of case studies. Practical work should involve the detailed study of one species and field observations of appropriate conservation areas.
Part V	I.	The Molecule and the Cell	Experience elsewhere has highlighted two difficulties in this work. (i) There is grave danger of both pupil and teacher becoming lost in the detail of complex biochemical pathways and so fail to see the principles. (ii) It is difficult to arrange appropriate laboratory activities that exactly parallel the concepts of the theory course. This section of the work, is, however, the corner stone of modern biology and must be included in any programme aiming to give a correct orientation, and understanding of the processes of life. It is recommended, therefore, that in the development of the text, biochemical aspects be reduced to simple word equations, with pathways omitting intermediate steps and showing only key chemical events. Only sufficient chemical formulae should be introduced to explain essential biochemical principles. For example in the citric-

acid cycle only the names of acids (and only of the main acids) should be shown with an indication of the number of carbon atoms in each.

Extensive use should be made of simple diagrams and models, especially of the ultrastructure of the cell and of large molecules such as DNA or RNA. Treatment should not be too unlike that given in the Time-Life 'Nature Library' book "Cells".

With regard to practical work, it is probably impracticable to attempt more than observations of cells under the light microscope, and simple experiments in 'whole cell' physiology, e.g. osmotic relationships between the cell and its environment. Some work, too, can be done on the properties of chlorophyll. But the bulk of the experiments in this section could be selected from those traditionally used as part of the programme for whole organism biology. These could be used to accompany cell theory and help pupils appreciate the role of cells in the activities of the organism as a whole. In the following table, some suitable experiments have been suggested.

Topic in Cell Biology	Example of Relevant Experiment on the Whole Organism
1. The biochemistry of photosynthesis	1. CO_2 is needed for photosynthesis, O_2 is produced by green plants. Light intensity influences the rate of photosynthesis.
2. Release of energy in cells	2. Whole organisms use oxygen and release carbon dioxide in respiration.
3. Cells require raw materials from food - glucose, amino acids, etc.	3. Food is changed chemically by enzymes.
4. Activities of cells are controlled by enzymes	4. The rate of action of enzymes is influenced by factors such as concentration, temperature and acidity.
5. Cells are influenced by the osmotic pressure of the environment	5. Stems wilt or become turgid in sugar solutions of various concentrations.

		Incidentally, excellent 8 mm single concept movie film loops are available on topics such as cell division, the role of DNA is the control of the activities of the cell, enzyme action, photosynthesis, the growth of cells and the release of energy in cells. It is suggested that investigations be made of the possibility of using similar materials in India.
Part VI	Genetics and Evolution	Probably the most effective way of organising the genetics part of the course is to describe the history of the discovery of the various concepts.

(The ideas of Mendel, Sutton, Morgan, etc. leading to recent workers such as Watson and Crick). In this way the processes of science will be emphasised. The history of the understanding of genetical concepts is a classical example of how ideas are discarded, modified or enhanced by subsequent ideas and discoveries. Some experience of practical genetics at this stage is, of course, essential. Cultures of pure-breeding mice or of Drosophila are possibly difficult to supply to schools. It is recommended, therefore, that the Department of Agriculture of the Ministry of Food and Agriculture, be asked to investigate the possibility of producing large quantities of pure-breeding seeds of distinct varieties of common crop plants (for example, albino and wild-type tobacco plant which segregates 3:1). These should be made available to schools for experimental work.

Evolution should also be taught historically with some discussion of Lamarck, Darwin and later workers. Stress should be placed on the role of inheritance of chance variations, (i.e. on the place of modern genetics in evolutionary theory), and on the process of natural selection. Evidences for evolution have been treated thoroughly in Part III and should not be considered again. Evolution should now be accepted without consideration of further evidence and have the status of a Law. To emphasize the processes of science, and also to provide a 'case study', the evolution of the primates should be studied in some detail. This would also provide material for practical work through observations of primates in zoos, museums and game parks. In considering evidence for evolution of the primates, the family tree constructed only from the evidence provided by living (modern) types should be compared with the family tree constructed from the evidence of Palaeontology.

In the case of man some attention should be given to cultural evolution as well as to his biological evolution.

CONCLUSION

The implementation of a syllabus as modern and forward-looking as that proposed in the present draft should be a source of great satisfaction to science educators in India. It does, however, imply the need for a massive new programme of teacher education - both pre-service and in-service. The syllabus contains information and concepts that have not been taught in conventional college of university courses in biology anywhere in the world until very recently. Many teachers, probably the great majority, will be unfamiliar with the concepts and with the approach.

It is recommended that teachers colleges and universities be sent copies of the new syllabus as soon as it is approved and that a conference be sponsored by NCERT to design a suitable curriculum for training courses for future teachers.

It is further recommended that a large programme of in-service training should begin as soon as possible to acquaint established teachers with the new work.

3/10/1968

G.R. Meyer

APPENDIX G

OUTLINE OF CONTENT FOR BOOK IV (CLASS IX) BIOLOGY

Suggestions submitted for discussion by G.R. Meyer
November, 1968

BIOLOGY PART IV : SCIENCE FOR HIGH SCHOOLS

I. Introduction (2 periods)

Chapter 1. The Scope and Value of Biology

Author : Dr. S. Doraiswami
Periods : 2
Summary : 1. Aims and Problems

The problem of distinguishing between the living and the non-living. The way a scientist studies both the structure and function of living things. Definition of terms morphology and physiology. Biologists are also interested in diversity and in classifying living things into natural groups.

The growth and development of plants and animals are also major problems of interest to biologists. Definition and explanation of term embryology.

Animals and plants are sensitive to changes in their environment, retaining a normal relatively constant morphology and physiology in spite of external changes. This state of constancy is studied by biologists and is called homeostasis. The relationship between organism and environment, though, is studied by biologists at every level or organisation. Cells, tissues, organs, the whole organism and populations or organisms, all respond to changes in their environment.

Definition of terms population, community, biosphere and ecology. Concept and definition of behavdour.

Biologists also study the processes causing variation and the processes of inheritance. Definition of genetics.

The study by biologists of life in the past. Concepts of fossils, evolution and adaptation.

2. The Processes of Biological Science

The method of inquiry and investigation in biology. The logic of science. The dependence of biologists on quantitative measurements and accurate observations and their use of experiments. The importance of this method in solving problems both in science and in every day life.

The history of biological concepts and discoveries. How scientific ideas grow and develop.

3. Importance of Biology to Man

Biology helps man understand and combat disease. Knowledge of the biology of disease organisms can lead to their control. Biologists, too, by investigating the processes of life give the medical profession a clearer understanding of the causes of illness. Biology is the basis of scientific agriculture and forestry. Consideration of selective breeding and of the control of the environment to ensure the best yield. Biology also has contributed to technology by improving natural raw materials and by showing the way to make maximum use of the products of living things. There is danger, though, that man may spoil his environment or waste his resources. Concept and definition of conservation.

4. Levels of Organisation

Living things may be studied at three levels or organisation. At the level of molecules and cells, at the level of the tissues and organs of the whole organism and at the level of population of organisms. The relationships between the three levels. The reaction at each level to changes in the environment.

The organisation of the textbook in terms of these levels. Modern biology is best studied this way because artificial divisions of the subject such as botany, zoology, physiology, genetics, etc., are no longer useful when we consider the process of life.

Sources :

1. Maheshwari, P. and Manohar Lal, Biology : A Textbook for Secondary Schools. Section I Some Basic Facts about Life. Delhi. NCERT 1964. Chapters 1 - 3, pp. 1-24.
2. Moore, John A. et al. Biological Science - An Inquiry into Life. New York, Harcourt Brace and World Inc. Indian Edition NCERT 1964. Chapter I Biology - What is it About? pp. 3-10.
3. Messel, H. (Editor). Senior Science for High School Students. Part 3 Biology. Sydney University Science Foundation for Physics. Sydney 1966. Introduction pp. 13-15.
4. Schwab, J.J. Biology Teachers' Handbook. New York, John Wiley and Sons Inc. 1963. Chapter 2 The Levels of Biological Organisation pp. 9-13. Chapter 3 Aims and Objectives of the BSCS Materials pp. 30-42.
5. Nuffield Biology. Introducing Living Things Text L London, Longmans/Penguin 1966. Chapter 2 Investigating Living Things pp. 30-32.

II. The Organism (32 periods)

Chapter 2. The Organism is a Living System

Author : Dr. V. Galakhov
Periods : 6
Summary : 1. The Difference Between the Living and the Non-Living

The significance of movement, responsiveness, assimilation, growth with development, and reproduction as characteristics of living things. The problem of deciding between living and non-living. The nature and properties of viruses.

2. The Organisation and Co-ordination of the Plant Body

The structure and functions of the root and shoot systems of a green plant. Processes of movement, responsiveness, assimilation, growth with development, and reproduction in the plant body. Concept of cell, tissue, organ, and organ system in the plant body. Homeostasis in the green plant.

3. The Organisation and Co-ordination of the Animal Body

The systems of the animal body responsible for movement, responsiveness, assimilation, growth with development and reproduction. External features and organ systems in a mammal. Concept of cell, tissue, organ and organ system in the body of the mammal. Homeostasis in the mammal.

4. Variations on a Plan

While the basic processes of living things are the same from plant to plant, and animal to animal, there are variations in the way these processes are organised. Animals and plants pass through a cycle of growth, reproduction and death. Concept of life cycle. Processes of life at different stages of the life cycle. Plants and animals have differences in the way their life processes are organised.

There is a vast diversity of plants and animals and while all share the common processes of life there are many differences in the structure of the organs and organ systems that have been evolved to bring about these processes of life. These are, however, just differences at the level of organ and organ system. The fundamental processes at the level of the cell remain basically the same.

All organisms act as co-ordinated wholes in response to changes in the environment.

Sources :

1. Nuffield Biology. Text III The Maintenance of Life. Text IV Living Things in Action. Text V The Perpetuation of Life. London, Longmans/ Penguin 1966.

2. Moore John A. et al. Biological Science - An Inquiry into Life. New York, Harcourt Brace and World Inc. Indian Edition NCERT 1964. Especially chapters 14 - 17, and 21 - 29.

3. Messel H. (Editor). Senior Science for High School Students. Part 3 Biology. Sydney University Science Foundation for Physics. Sydney 1966. Chapter 10 Integration in an Animal.

4. Schwab, J.J. Biology Teachers' Handbook. New York, John Wiley and Sons Inc. 1963. pp. 37 - 39 Regulation and Homeostasis.

Chapter 3. Micro-organisms. Features of their Life Processes

Author : Dr. L.M. Lakshmann
Periods : 6
Summary : 1. Bacteria

Discovery of bacteria. Work of Leeuwenhoek. Problems of classification - plant, animal or protista? Shape and size of bacteria. Cell structure - special stress on the presence of DNA. Structure as revealed by the electron microscope.

Formation and significance of endospores. Motility - structure and functions of flagellae.

Nutrition - heterotrophic and autotrophic forms and processes; saprophytic bacteria.

Reproduction - cell division and life cycle. Population growth of a bacterial culture.

2. Viruses

Discovery of viruses : tobacco mosaic virus, work of Adolf Mayer in 1886, and of Dimitrii Ivanowski in 1890. Isolation in U.S.A. of the tobacco mosaic virus in the 1930's.

The nature of viruses. Bacteriophage. Size, shape of viruses, structure of the virus as shown by the electron microscope. The RNA or DNA core and the protein sheath. Reproduction of viruses - the cycle of events in bacteriophage. The question whether or not viruses should be considered as living things.

3. The Importance of Micro-organisms to Man

Harmful bacteria. Work of Pasteur and Koch. Nature and definition of disease. Concept of pathogen. How pathogens enter the host and their effects on the body. The control of disease by the host. Antibodies, immunity. Antibiotics. Spoiling of food. Control of spoilage. Beneficial bacteria in medicine, industry and agriculture.

Sources :

1. Maheshwar, P. and Manohar Lal. Biology : A Textbook for Secondary Schools Section 2 The Diversity of Plant Life. Delhi NCERT 1964. Chapter 19 Microbes and Viruses.

2. Moore, John A. et al. Biological Science - An Inquiry into Life. New York, Harcourt Brace and World Inc. Indian Edition NCERT 1964. Chapters 9, 10 and 11.

3. Nuffield Biology. Life and Living Processes Text II. London, Longmans/ Penguin 1966. Chapters 1 - 4, pp. 1-55.

4. Morgan, D. (Editor). Biological Science : The Web of Life. Canberra, Australian Academy of Science 1966. Chapter 6 Micro-organisms.

Chapter 4. Characteristics of the Life Processes of Plants

Author : Dr. L.M. Lakshmann
Periods : 8
Summary : 1. Photosynthesis

The structure of the leaf - external morphology, internal tissues. Concept of photosynthesis. The role of light in photosynthesis. Functions of Chlorophyll, water and carbon dioxide. The structure and functions of the chloroplasts. The structure and functions of the stomata. Factors influencing the rate of photosynthesis.

2. Respiration

Gaseous exchange in plants - the need for oxygen and the release of carbon dioxide. The organising and use of carbohydrates as a source of energy.

3. Absorption, Transport and Storage of Materials

Absorption of materials by the roots. Conduction of water in root and stem. Translocation of high energy substances from leaves. Problems of transportation in xylem and phloem. Storage of materials in plants.

4. Reproduction and Development

Concepts and examples of sexual and asexual reproduction in the plant kingdom.

The structure of the flower and the functions of the parts. Brief treatment of the life cycle of the flowering plant - growth, with development and differentiation. Brief account of some of the environmental changes that can influence growth and development.

Sources :

1. Moore, John A. et al. Biological Science - An Inquiry into Life. New York, Harcourt Brace and World Inc. Indian Edition NCERT 1964. Chapters 15 and 16.

2. Morgan, D. (Editor). Biological Science : The Web of Life. Canberra, Australian Academy of Science 1966. Chapters 20 Photosynthetic Systems, and 21 Transport System in Plants.

3. Nuffield Biology. Text III The Maintenance of Life. Longmans/Penguin 1966. Chapter 7 Plants and the Atmosphere, Chapter 8 Plants and Light Energy, and chapter 9 The Organism and Water. Text II Life and Living Processes. Chapter 8 How Plants Reproduce and Make Seeds, Chapter 9 Growing Up. Text IV Living Things in Action, Chapter 8 Mass Flow Systems in Plants.

Chapter 5. Characteristics of the Life Processes in Animals

Author : Dr. V. Galakhov
Periods : 12
Summary : 1. Evolutionary Trends in the Life Processes of Animals

Brief account of the progressive changes in the main organ systems of animals from protozoa to vertebrates, e.g. changes in the digestive system from vacuoles, to two-way-gut to one-way-gut.

2. Trends in the Evolution of Transportation Systems in Vertebrates

Evolutionary trends in the structure and functions of the heart and blood vessels in protochordates, fishes, amphibians, reptiles and mammals.

3. Trends in the Evolution of Respiratory Systems in Vertebrates

The adaptive features of the respiratory systems of fishes, amphibians, reptiles, birds and mammals. Changes in the systems are related to the change from life in water to life on land. Changes in structure and function of the respiratory system are related to the parallel changes in the transport system.

4. Life Processes in an Organism Respond to Changes in its Environment

An organism has sense organs to detect changes in the environment; systems to relay the messages from the environment to co-ordination centres, and systems to send messages and cause co-ordinated responses in effector organs.

The physiology of the nerve impulse and hormonal control. Responsiveness to environment is the basis of adaptive behaviour.

5. Animal Behaviour

The behaviour of some animals is controlled almost entirely by inherited patterns while in others, behaviour is mainly learned. Case studies of patterns of behaviour mainly inherited and with little learning. The behaviour of bees. Hive building, division of labour in the hive; navigation and communication. Territoriality and migration in birds. Case studies of patterns of behaviour mainly learned. Exploration of environment (maize running) by rodents. Learned behaviour in primates. Adaptive behaviour of animals living closely associated with man, crow, pigeon, rodents.

Sources :

1. Moore, John A. et al. Biological Science : An Inquiry into Life. New York, Harcourt Brace and World Inc. Indian Edition NCERT 1964. Chapters 21 to 29.

2. Messel, H. (Editor). Senior Science for High School Students. Part 3 Biology. Sydney University Science Foundation for Physics. Sydney 1966. Chapter 11 Behaviour of Animals.

3. Nuffield Biology. Text IV Living Things in Action. London, Longmans/Penguin 1966. Chapter 9 Organisms Behave, and chapter 15 Behaviour and Survival.

III. Populations (56 periods)

Chapter 6. Population Ecology

Author : Mr. G. Raju
Periods : 12
Summary : 1. The Concept of Distribution and Abundance

Definition of distribution and abundance. Simple case study of distribution of familiar species in India.

2. The Chance to Survive and Multiply

Special ecological meaning of the terms survival, multiplication and environment. Concept of life table with illustrations from human population in Europe and Asia. Birth rate and death rate leading to concept of multiplication of a species. Rates of increase in numbers. Fluctuations of the human population.

3. The Nature of the Environment

Environment of an organism is precisely defined by an ecologist as 'anything that affects the organisms chance to survive and multiply'. Five components of environment : weather, resources, members of the same species, members of other species, and hazards. Weather : temperature, moisture, light and acidity. Distribution and adaptations in rainforests and deserts. Resources : food, materials for building nests and provisions of shelter and cover. Quantity and quality of the resource. Members of the same species :

concepts and case studies of over population and crowding. Members of other species : mutualists, predators - including some account of biological control, disease. Non-predators sharing the same resource.

4. Changes in Distribution and Abundance Due to Natural Courses

Major changes resulting in extinction of some species and colonization by others. The influence of long term changes of climate on populations. The concept of colonization. Succession. The distinction between succession and stratification or zonation.

Source :

1. Messel, H. (Editor). Senior Science for High School Students. Part 3 Biology. Sydney University Science Foundation for Physics. Sydney 1966. Chapters 6, 7 and 8.

Chapter 7. Ecosystem and Biomes

Author : Mr. G. Raju
Periods : 16
Summary : 1. Producers, Consumers and Decomposers

Definitions of the above terms. Concepts of food and energy chains and webs. Concept of food or energy pyramid : producers and first, second and third order consumers. Role of decomposers.

2. Communities

Concept and definition of terms community and habitat. Classification of communities. Inter-relationships within a community. Direct and indirect relationships. The concept of the ecosystem : food webs as the regulators of existence in a community.

3. Living in Freshwater

The conditions of the freshwater habitat. Requirements of freshwater organisms. Problems of life in freshwater. Description and discussion of a pond community.

4. Living in the Sea

Conditions of the marine habitat : salinity, light and temperature. Requirements of life in the sea. Special conditions of the environment and the communities existing in deep water, floating in the open sea and on the edge of the sea.

5. Artificial Ecosystems

Brief consideration of aquaria, agricultural fields and other man-made communities.

6. Distribution of Living Things on Earth

Concept of distribution. Case study of distribution. Concepts of barriers, e.g. Wallace's line. Concept of dispersal. Explanations of the spread of living things : migration, continental drift-evidence from unexplained absences and discontinuous distributions. The main biomes (plant and animal geographical regions). Adaptive features of organisms of the biomes.

Source :

1. Morgan, D. (Editor). Biological Science : The Web of Life. Canberra, Australian Academy of Science. 1966. Chapters 1, 3, 7, 8, 9 and 14.
2. Moore, John A. et al. Biological Science - An Inquiry into Life. New York, Harcourt, Brace and World Inc. Indian Edition NCERT 1964. Chapters 8 The Balance of Nature, and 39 The Living World.

Chapter 8. The Biosphere

Author : Dr. V. Galushin
Periods : 12
Summary : 1. Balance of Nature - Chemical Cycles

Living things have been using chemical raw materials for thousands of millions of years but supplies have not been exhausted - why? The concept of the 'economy of nature' and the exchange of chemicals between the living and the non-living world.

2. The Carbon-Hydrogen-Oxygen Cycle

Cycles between producers, consumers and decomposers. Gaseous exchanges between these groups.

3. The Nitrogen Cycle

Cycle of nitrogen between plants, animals and decomposers. The importance of bacteria in decomposition. The roles of nitrifying, dentrifying and nitrogen-fixing bacteria and algae in the cycle of nitrogen.

4. The Phosphorous Cycle

Comparisons between situations on land and in the ocean. Cycle of phosphorous between plants, animals, decomposers and inorganic phosphates. Relationship of the cycle to geological processes of rock formation and weathering.

5. The Cycle of Water

Return of water to the atmosphere by evaporation from soil and water surfaces, by respiration of plants and animals, and from plant transpiration. Return of water to surface as rain, snow, dew and frost. Movement of water in soil, water table, continuity of cycle.

6. Transformation of Energy

The one-way flow of energy into biological systems. The flow and transformations of energy within the biosphere. The relationship with food chains and food cycles. The transformation of energy in the marine community.

7. The Biosphere Results from the Processes of Evolution

Evolution has produced living things adapted or fitted to their environment which includes adaptive inter-relationships with other living things. The total biosphere is thus the end product of the processes of adaptive evolution.

8. Man in the System of the Biosphere

Man has made use of the natural ecosystems of the biosphere as a source of his raw materials. He has manipulated the biosphere for his own needs and has constructed many of the artificial ecosystems such as the agricultural ecosystems that were discussed in chapter 7.

Man needs to learn to manage his environment and conserve his resources (see chapter 9).

Source :

1. Moore, John A. et al. Biological Science : An Inquiry into Life. New York, Harcourt Brace and World Inc. Indian Edition NCERT 1964. Chapter 8 The Balance of Nature.

2. Morgan, D. (Editor). Biological Science : The Web of Life. Canberra, Australian Academy of Science 1966. Chapter 1 The Web of Life, chapter 16 Man in the Web of Life.

3. Messel, H. (Editor). Science for High School Students. Vol. I. Sydney Nuclear Research Foundation 1963. Chapter 21 Living Communities.

4. Maheshwari, P and Manohar Lal. Biology : A Textbook for Higher Secondary Schools. Section 6 Evolution, Heredity and Adaptation, and Section 7 General. Chapter 53 Organisms in Relation to their Surroundings, and chapter 55 Interdependence of Plants and Animals.

Chapter 9. Conservation of Nature

Author : Dr. V. Galushin
Periods : 16
Summary : 1 Nature of the Earth as the Environment in Which Man Lives and Also a Resource for His Existence

Preservation and continuity of circulation of substances in nature is a safeguard for the continuation of life on earth.

Changes capable of distorting the normal processes of the biosphere : excessive accumulation of carbon dioxide in the atmosphere, increasing radiation, drastic removal of the green protective cover of the earth, etc. Irrevocability of some natural processes.

Natural resources are the basis of man's economic activities. Man must learn to replace and conserve his resources. Conservation of nature is the science of how to use nature in a rational way.

A brief outline of the background of conservation of nature in India and other countries.

2. Conservation of Atmospheric Air, Water Resources and Soil

Cleanliness of air and water is one of the basic conditions for normal life processes. Causes of the pollution of air. Results of such pollution. Methods of preventing air pollution. The problem of the shortage of fresh water. The diminishing water-carrying capabilities of rivers; its causes and consequences. Pollution of water.

Measures to prevent water pollution and to conserve its storage on the earth.

Soil fertility as the main basis of the food supply for man. Soil erosion - what causes it and methods of prevention; overcoming its consequences.

3. Conservation of Plants

The role of the green cover of the earth in the formation of organic substances, restoration of oxygen and maintenance of the cycles of the biosphere.

The plant resources of the earth and causes and results of reducing their populations.

Measures to conserve and restore the green cover of the earth.

4. Conservation of the Animal World

The role of the animal world in keeping up 'the dynamic equilibrium' of natural communities. Role in the cycles of the biosphere. Reduction in the number of animals. Role in recent cases of extinction and near extinction. Problems of under population.

The numbers and rational management of game animals. Examples of restoring the number of the populations which were disappearing. Acclimatisation. Conservation of useful and rare animals.

5. Conservation of Natural Landscapes

Need to conserve natural environments. Reservations are yardsticks of nature. Main reservations in India and other countries.

National and international efforts in organising an effective system of conservation of nature.

6. Conservation and Ecology

Development of conservation depends on an understanding of the balance of nature. The principles of ecology give us the basis for scientific programmes of conservation.

Source :

1. Cull, R.G., McDonnell, K.S., and Meyer, G.R. Science and the Environment of Man. Brisbane, Jacaranda Press 1966. Chapter 36 Conservation of Resources.

2. Morgan, D. (Editor). Biological Science : The Web of Life. Canberra, Australian Academy of Science 1966. Chapter 16 Man in the Web of Life.

3. Nuffield Biology. Text IV. Living Things in Action. London, Longmans/Penguin 1966. Chapter 18 How Man May Effect His Surroundings.

APPENDIX H

REPORT TO BIOLOGY STUDY GROUPS ON BOOKS I - III FOR MIDDLE SCHOOLS (NCERT PROJECT), BASED ON POINTS MADE DURING A SEMINAR AT MADRAS ON 26.10.1968 BY DR. G.R. MEYER, UNESCO CONSULTANT WITH NCERT

The group should be congratulated on the sound biological content of the books. Any criticisms and comments made must be based on educational rather than biological issues - the biology is accurate and comprehensive. The Indian fauna and flora, for example, are well and sufficiently represented and this is a most important achievement.

1. The Need for Objectives

The arrangement and content of the books suggests that they did not emerge from a clearly stated set of objectives. Only by defining objectives very carefully can a set of criteria emerge which gives a rationale for accepting or rejecting a given topic.

At this stage it is still not too late, even though second best, to derive a set of objectives from the books produced and use those objectives as a ruthless editorial tool; matching all content against the objectives and removing all items that do not directly and obviously contribute to the achievement of the objectives.

2. The Need for Logical Structure

Carefully defined objectives usually lead to the formulation of a course with directly obvious internal structure. The lack of such stated objectives in this case has tended to produce books lacking structure. Topics are arranged in a haphazard manner and do not develop progressively or lead logically from one to the other. They do not reflect the conventional structure of biology, nor do they reflect clearly any alternative structure.

3. Amount of Material

In general there is too much material to be covered by pupils of Middle School age. The content could be cut by say 20% to 30%. Pupils of Middle School need plenty of time for revision, for opportunities to review work done before and plenty of time for enrichment projects, visits, discussions and practical work. A course too over-loaded with material defeats these important educational goals.

4. Style of English and Manner of Presentation

The style of the English is simple and direct. There is a tendency, however, to use too many technical terms. A good rule is to introduce a technical term only if it will be needed later in the text. Terminology for its own sake should be avoided.

The pages are rather crowded - too many concepts are crowded into a relatively small space. This would interfere with the process of learning. Pages should be less crowded and convey fewer concepts.

5. Descriptive Versus Investigational Type of Material

The balance between descriptive and investigational work is too much in favour of descriptive. This would be improved if there was a closer integration between structure and function. At present large sections of the book are concerned only with descriptive structure that serve only limited educational objectives.

Practical problems should be central in the activities of the pupil. Each topic should be introduced through some type of practical experience. A few genuine open-ended problems should be included to give pupils some insight into the methods of creative science.

The section in book I 'Experimenting with living', is an attempt to introduce the "enquiry" approach to the course. But it is very artificial to separate this into a special section of the book. Transfer of understanding from that section to the rest of the course will not occur as freely as anticipated. This section will be learnt in isolation and the point will be lost.

6. Questions

The questions at the end of each chapter are largely of the factual recall type. This is satisfactory as far as it goes provided that the answers to the complete set provide a general review of the contents of the chapter. In addition, however, questions should be included for discussion or for themes of essay, which require an understanding of the topic, through analysis of data or synthesis or evaluation of ideas.

All questions should be answered in the Teachers' Guide.

7. Illustrations

The illustrations are uneven in quality and variable in style. There is evidence that a number of different artists have prepared the illustrations and this detracts from the general unity of the books. Authors have not clearly decided on the functions of the illustrations. In a textbook of this type there should be illustrations of two types (i) those that authors expect pupils to know - to learn to draw from memory, and (ii) those that are there only for general understanding or enrichment. For example, it may be reasonable to ask pupils to memorise a drawing of the anatomy of the frog but only to look at pictures of the diversity of the amphibians. Illustrations intended to be memorised should be simple line drawings - one dimensional and without shading. Those meant only to be looked at by the pupil could be more artistic. This distinction, incidentally, has not been made in the BSCS books where the illustrations are all of the more artistic type and are particularly difficult for pupils to learn.

8. Repetition of Concepts

Book 2 repeats many concepts developed in books 1 and 3 by treating life processes, growth, reproduction and development, and food habits, as separate topics. This sort of treatment is educationally unsound because it deals with the various physiological processes as abstractions out of context of the whole organism. It is difficult for pupils to understand this type of abstraction. In fact, whole organisms have been torn apart in order to make artificial 'topics'. The concepts concerned could be dealt with more naturally as integrated phenomena within one or two organisms - say the green plant and the human body. This approach would be easier for pupils to understand - they would also better appreciate the inter-relationships between the various processes within an organism.

9. Teachers' Guides

At times the Guides have been padded out with material rejected from the texts. This is unsatisfactory. Material rejected from the text should be totally rejected.

The first volume of the Teachers' Guide should be introduced through a discussion of the philosophy of the course, its objectives and its structure. This is very important if teachers are to be given the correct orientation.

All questions asked in the text should be answered in the Teachers' Guide.

The description of the practical work is clear and very satisfactory.

10. Teacher Education

As soon as syllabuses and textbooks are finalised copies should be sent to all universities and teacher training institutions with requests to modify training programmes to give support for the new course.

NCERT should be asked to sponsor a conference of teacher educators to design a training course in content and method suitable for the new programme.

NCERT should be asked to mount a highly organised programme of in-service training of teachers.

Recommendations for Rearrangement of Texts to Simplify Objectives and Strengthen Logical Structure

1. Book I : should begin with a reduced and re-edited version of chapter IV 'Experimenting with the Living'. The ideas of the chapter should be repeated over and over throughout the 3 books and pupils should be referred back to the chapter throughout the texts.

The chapter V in Book I on 'Dispersal of Living Things' should be omitted and relevant concepts should be integrated in the sections on diversity.

Chapter II in Book I should be broken up and integrated with the sections on diversity. Chapter I 'Finding out About Plants' should be strengthened to give a reasonable treatment of the structure and function of the green plant.

2. Book II : this is the weakest book of the three containing artificially contrived topics. Chapters I, II and III are an over-elaborate treatment of the cell. Cells should not be taught as separate isolated topics at this level but integrated into the story of how animals and plants work. The detailed instructions on how to use a microscope could be reduced or omitted and would more properly be included in the Teachers' Guide. Cell division should be introduced only as a concept without details of the mechanism.

I suggest that volume II be rearranged as a course of the biology of man together with further work on diversity. Chapter I from volume III 'Human Body - A Biological Machine' could come forward to volume II and be expanded as the main topic of the second year programme.

3. Book III could remain essentially the same as at present with the deletion of 'Human Body' and substitution of evolution and/or genetics (from volume II chapter IV). The new structure of the course would thus be as follows :

Book I : The processes of science
The structure and function of the green plant
Diversity of living things - Part I
Book II : The human body - its structure and functions
Diversity of living things - Part II
Book III : Explanation of diversity - evolution
Explanation of diversity - genetics (if considered a suitable topic for Middle School)
Man and the biological world - microbes and man, personal hygiene, agriculture

APPENDIX I

A REPORT SUBMITTED FOR DISCUSSION TO A SEMINAR ON "IDENTIFICATION AND NURTURING OF SCIENTIFIC TALENTS", DEPARTMENT OF EXTENSION SERVICES, C.I.E. DELHI-7, OCTOBER 14 - 16, 1968

A selection of topics from the three levels of biological organisation. (A) the organism, (B) the population and (C) the molecule and the cell.

A Course of Twenty Lectures

I.	Organisms	Lectures
1.1	The role of hormones in human reproduction. The female sexual cycle. Family planning.	(1)
1.2	The physiology of the nervous system with special reference to the nature of the nerve impulse.	(1)
1.3	Animal behaviour with special reference to communication behaviour in social insects such as bees and to learning in mammals.	(2)
II.	Populations	
2.1	The influence of the environment on the distribution and abundance of organisms. The general principles of population ecology.	(2)
2.2	The evolution of man including his cultural evolution and changes in population.	(2)
2.3	Changes in natural populations due to man's interference. Overstocking and wind and water erosion. Deforestation and water erosion. Cultivation and arrival of weeds. Effects of fire on the composition of flora and fauna. Controlled exploitation by man-fisheries. Conservation as the conserving of plants and animals that otherwise might disappear because of man's activities.	(2)

III. The Molecule and the Cell

		Lectures
3.1	A study of DNA as the genetic material. RNA and the translation of the Genetic Code. A special study of the evidence obtained from bacteria and viruses for the genetic role of nucleic acids, e.g. bacterial transformation; bacteriophage; RNA - containing viruses. (This section will require some knowledge of the structure of bacteria and viruses).	(2)
3.2	The role of enzymes in biological systems - the protein nature of enzymes. The production of proteins controlled by DNA. The mode of action of enzymes. Influence of concentration, acidity and temperature on action of enzymes.	(2)
3.3	Photosynthesis. The overall reactions of photosynthesis emphasizing the reduction of carbon from CO_2 to CH_2O with a large increase in potential energy. The two components of the overall reaction, each occurring in separate parts of chloroplast. (i) The 'light' reactions. The production of ATP and reduced co-factors is the unique feature of photosynthesis and (ii) carbon fixation - formation of organic compounds.	(2)
3.4	The utilization of nutrients in cells A. Respiration; its roles in making energy available to the cell in the form of ATP, together with a variety of simple organic molecules. The step-wise oxidation of sugar. B. Synthesis; the use of the products of respiration for synthesis of components of protoplasm such as carbohydrates, fats and amino acids (for proteins see 3.2 above).	(4)

UNESCO Science Teaching Project
14.10.1968

V.M. Galushin
V.I. Galakhov
G.R. Meyer

APPENDIX J

LECTURES, SEMINARS AND TALKS GIVEN DURING PERIOD OF CONTRACT

1. Short-Answer Examining. Seminar with UNESCO Science Teaching Experts, NCERT, New Delhi. 17th September.
2. Developing an Accelerated Course in Biology for Talented Students. Seminar with Department of Extension Services, Central Institute of Education, Delhi-7. 14th October.
3. Principles of Curriculum Construction and Biology Courses for Middle Schools. Seminar with Biology Study Group, NCERT - University of Madras. 25th October.
4. Advice on a Curriculum for Higher Secondary Schools in Biology. Seminar with Biology Study Group. NCERT - University of Madras. 26th October.
5. Science Curriculum Improvement Talk to staff of Science Education Department of SCERT, Hyderabad. 29th October.
6. Teaching Centres - A New Concept in Education. Lecture to NCERT, New Delhi. 1st November.
7. Interests in and Attitudes to Science Courses in Secondary Schools. Research Seminar for Research Study Circle of the Central Institute of Education, Delhi-7. 22nd November.
8. Objective Examining in Science. Lecture to the NCERT Science Teacher Training Programme, NCERT, New Delhi. 23rd November.
9. Constructing Multiple Choice Examinations in Biology. Leading a Teachers' Workshop in the NCERT Science Teacher Training Programme, NCERT, New Delhi. 25th November.
10. Current Trends in Australian Education. Lecture to the Alumni Association of the Central Institute of Education, New Delhi. 27th November.

APPENDIX K

FINAL PROGRAMME OF ACTIVITIES AND NAMES OF COLLEAGUES - SEPTEMBER TO NOVEMBER 1968

Activity	Date Started	Date Finished
1. Becoming familiar with materials :		
Report of UNESCO Planning Commission, Government of India	4.9.68	20.9.68
Report 'Position of Science in Secondary Schools'		
NCERT Biology texts		
New Syllabuses for - 1. Middle School 2. Higher Secondary		
New texts and related materials		
2. Visits to schools in Delhi, Madras and Hyderabad (a) using NCERT materials; (b) not using these materials	7.9.68	continuous to 30.11.68
Suggestions given to teachers and principals on methods of teaching and interpretation of curriculum		
3. Discussion with Biology Group on :		
(a) Syllabus for Grades VI to VIII	16.9.68	24.9.68
(b) Syllabus for Grades IX, X, XI	25.9.68	18.10.68
(c) Content and approach of books produced so far	15.10.68	27.11.68
4. Discussion with Department of Curriculum and Evaluation NCERT on methods now used in evaluation at Grade VIII level	12.9.68	4.10.68
5. Preparation of Unit Tests in Biology and help in preparation of tests for Physics and Chemistry. Origin of model for evaluation of Project as a whole	13.9.68	continuous to 27.11.68

Activity	Date Started	Date Finished
6. Lectures to UNESCO Experts and to Staff of Science Education Department of NCERT		
(a) Short-Answer Examining		17.9.68
(b) Curriculum in Middle Schools		25.10.68
(c) Teaching Centres - A New Concept in Education		1.11.68
(d) Evaluation of Achievement in Science		23.11.68
(e) Objective Tests in Science		25.11.68
7. Discussions with Biology Group on structure of textbook for Grades IX to XI	16.10.68	10.11.68
8. Visit to the State Institute of Education, Hyderabad. Seminar with staff - Introduction of materials of the UNESCO/ NCERT Project. Explaining teaching plan and evaluation of materials	1.10.68	10.10.68
9. Discussions with NCERT Study Groups in Biology in Madras and Hyderabad; Seminars with staff of universities on science curriculum	24.10.68	31.10.68
10. Assistance with Science Talent Quest Seminars	14.10.68	16.10.68
11. Lectures to Institutes of Education, Research Groups, Universities, etc. - by invitation	At times to be arranged (see Appendix J)	

List of Colleagues in NCERT

I. UNESCO Experts :

Professor S.A. Balezin	Chief Technical Adviser
Dr. A.V.B. Brared	Mathematics
Dr. V.M. Galushin	Specialist in Biology
Dr. V.I. Galakhov	~~Teaching Mathematics~~ Specialist in Biology.
Dr. L.V. Levchuk	Specialist in Chemistry
Dr. Y.I. Narmov	Specialist in Chemistry
Dr. A.A. Margolis	Specialist in Physics
Dr. A.A. Tamarin	Specialist in Physics
Mr. B.I. Bukhalov	Design of Science Equipment
Mr. R.A. Abulkhanov	Interpreter

II. Administrative Staff of Department of Science Education :

Dr. M.C. Pant	Head of the Department of Science Education
Mr. N.K. Sanyal	Deputy

III. Biology Counterparts :

Dr. S. Doraiswami	Botanist
Mr. G. Raju	Zoologist
Miss S. Mazumdar	Botanist
Mr. S.P. Sharma	Zoologist
Mr. K.B. Gupta	Assistant
Mr. Rajendra Prasad	Biologist
Mr. L.M. Lakshmann	Biologist

APPENDIX L

PHOTOGRAPHS

Plate I. Some Members of the UNESCO/NCERT Staff Working on the Secondary School Science Project

1. Professor S.A. Balezin, Chief of Mission, prepares a report.
2. Dr. G.R. Meyer, UNESCO Consultant, working on curriculum materials.
3. Mr. I. Abulkhanov (Interpreter) dictates to a stenographer.
4. Two NCERT Biologists Mr. Rajendra Prasad and Dr. L.M. Lakshmann.
5. Three Biologists : Dr. V. Galushin (left)
   Miss S. Mazumdar (centre)
   Dr. V. Galakhov (right)
6. Miss Mazumdar and Dr. G.R. Meyer discuss changes in a biology syllabus.
7. Dr. Galakhov writing material for a teachers' Study Guide in biology.
8. Dr. Narmov (Chemistry Expert) and Mr. Bundari (Chemistry counterpart) discuss a chemistry outline while Dr. Galushin prepares biology materials at a nearby desk.

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Plate II. The National Council for Educational Research and Training New Delhi. General Buildings and Science Materials Resources Centre

9. Main building - southern wing
10. Main building - lecture theatre
11. Main building - main block
12. Residential hostel
13. New building on campus of NCERT (under construction)
14. Science Materials Resources Centre - science equipment
15. Science Materials Resources Centre - science equipment
16. Science Materials Resources Centre - display of equipment and techniques

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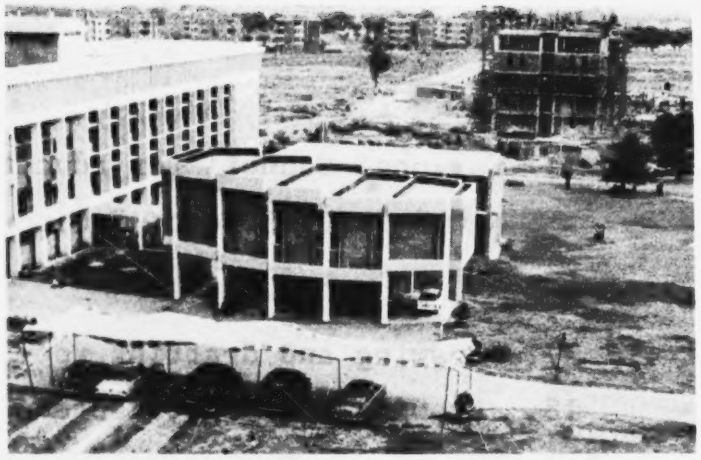
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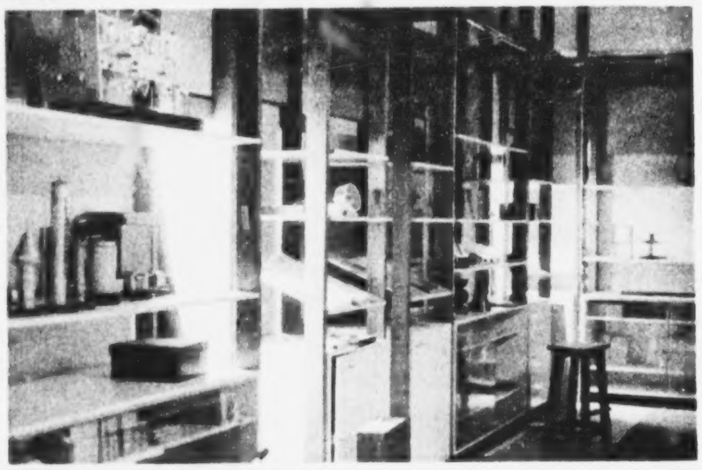
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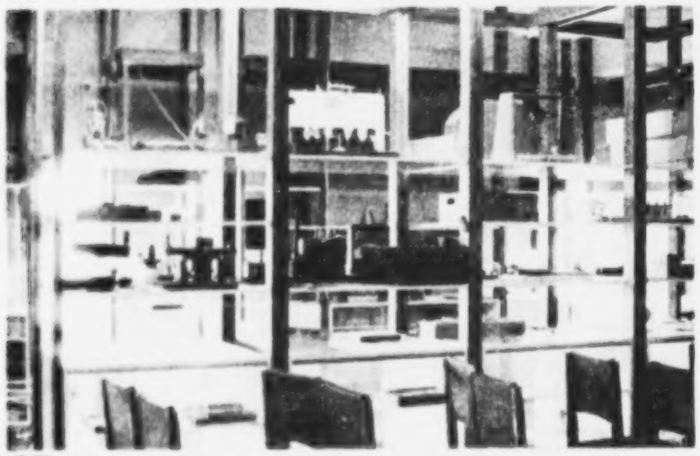
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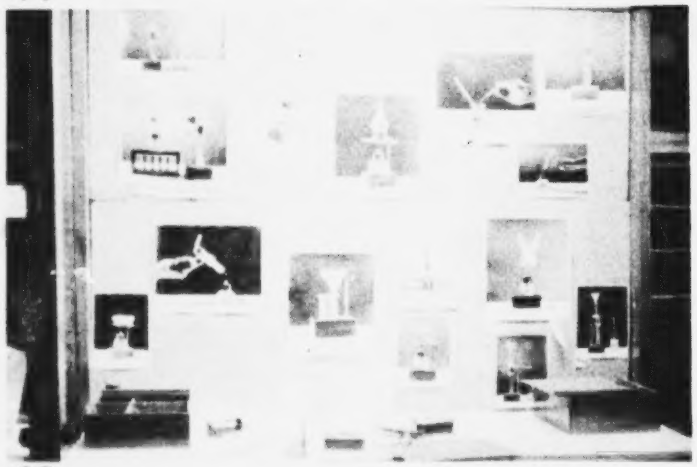
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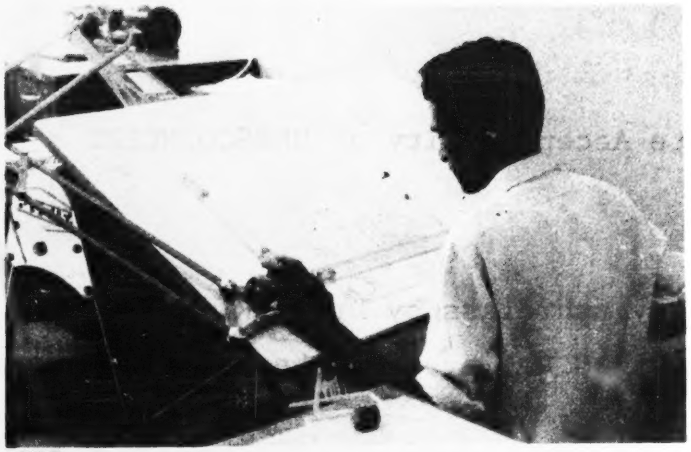
Plate III. National Council for Educational Research and Training New Delhi. Science Equipment Workshops

17. Drawing and drafting room. Preparing a blueprint
18. Drawing and drafting room. Drafting a plan
19. Metal workshop. Benches
20. Metal workshop. Lathes
21. Metal workshop. Making equipment for physics
22. Metal workshop. Making geometrical shapes
23. Metal workshop. Demonstration of equipment
24. Wood workshop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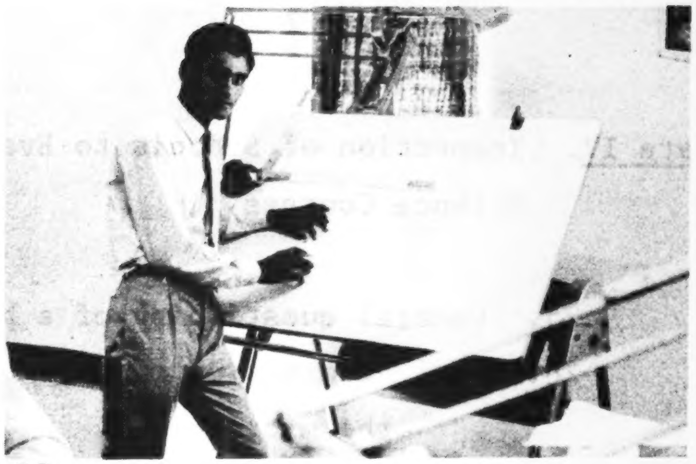
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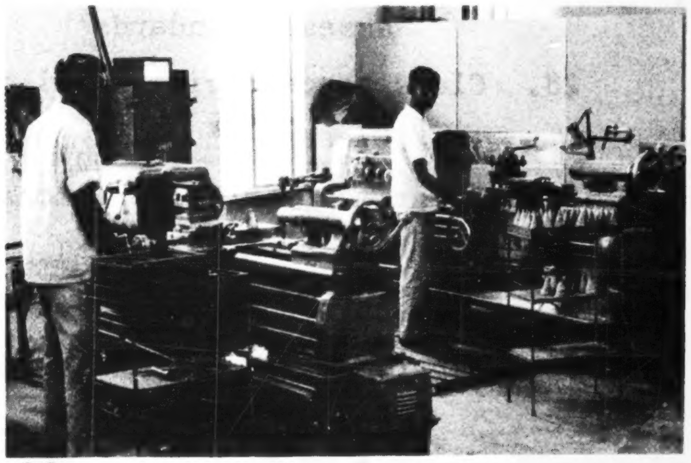
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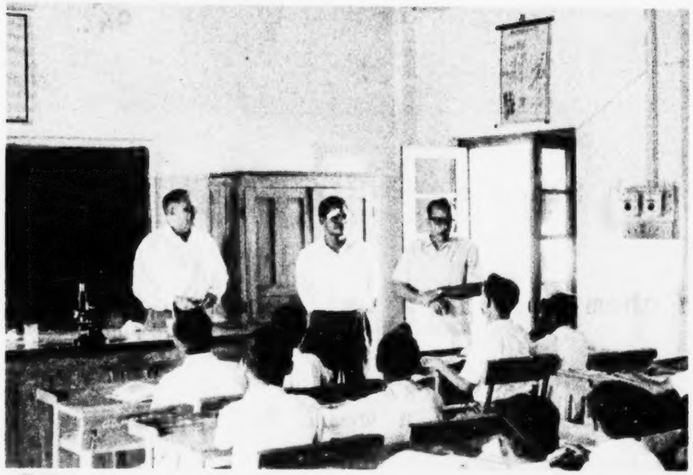
Plate IV. Inspection of Schools to Evaluate Acceptability of UNESCO/NCERT Science Courses

25. General questioning of a biology 6th class by Dr. G.R. Meyer
26. Oral examination of pupils by Dr. G.R. Meyer on the use of the microscope
27. Dr. G.R. Meyer teaches a lesson on Arthropods to Class 7 to assess standards
28. Class teacher gives oral quiz to a chemistry pupil in Class 8
29. Experiment in NCERT Demonstration School to compare classes V and VI biology. I. Regular class teacher gives lesson on seed germination to Section 5A
30. Experiment in NCERT Demonstration School to compare classes V and VI biology. II. Reaction of Section 5A to the lesson on seed germination shown in photograph 29.
31. Experiment in NCERT Demonstration School to compare classes V and VI biology. III. Same topic as in photograph 29, taught to Section 5B by NCERT Visiting Teacher
32. Experiment in NCERT Demonstration School to compare classes V and VI biology. IV. NCERT Visiting Teacher gives objective test to Section VB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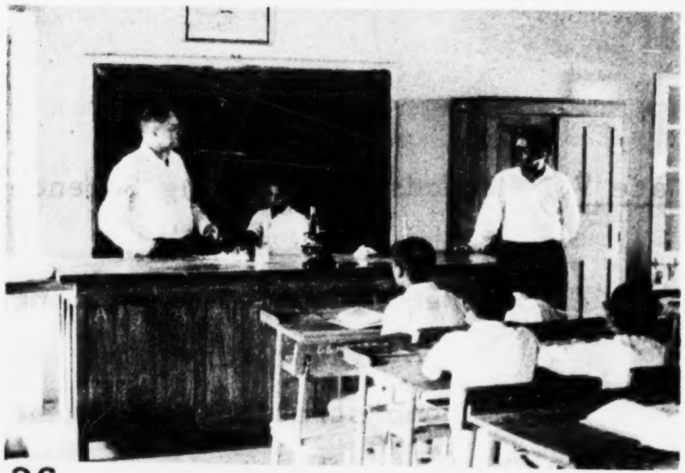
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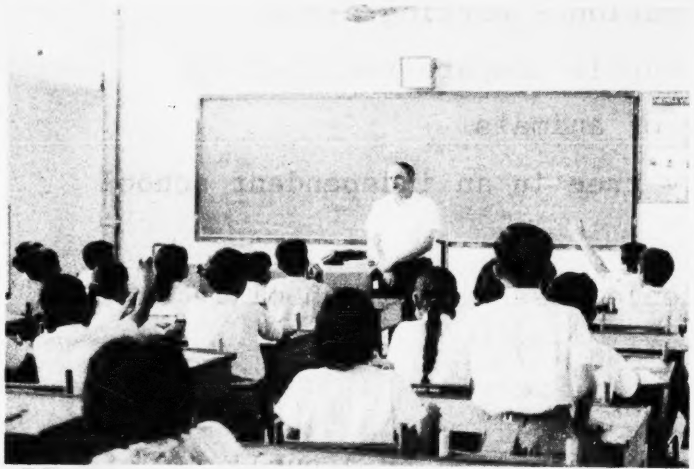
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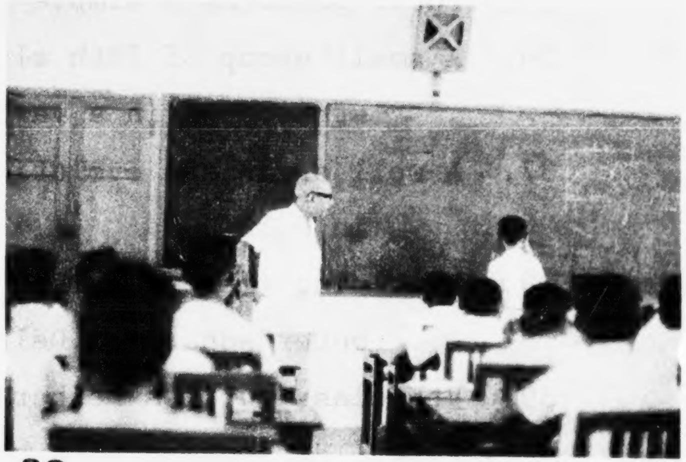
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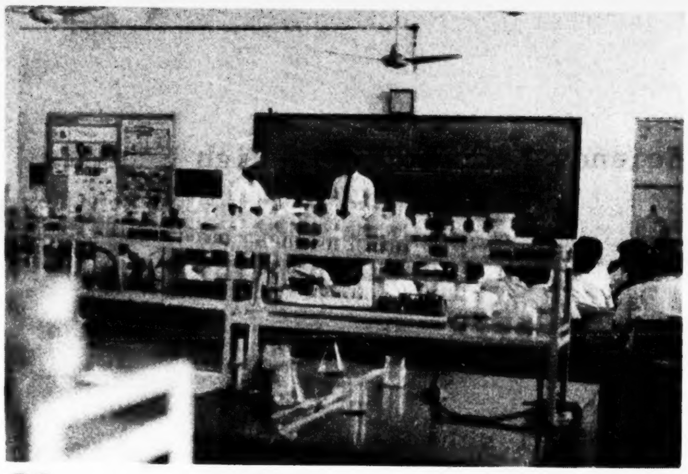
Plate V. Methods of Teaching Science in High Schools

33. Demonstration experiments in chemistry in a well equipped laboratory
34. Demonstration experiments in chemistry in a well equipped laboratory
35. Pupil performs a simple filtration - working alone
36. A small group of IXth class pupils compare respiratory structures in a variety of animals
37. A well organised evolutionary tree in an independent school in Delhi
38. Listening to a televised science lesson in a school in an outer suburb of Delhi (class IX)
39. Vth class pupil's herbarium book
40. Formal dissection of a cockroach prepared by a pupil in XIth class



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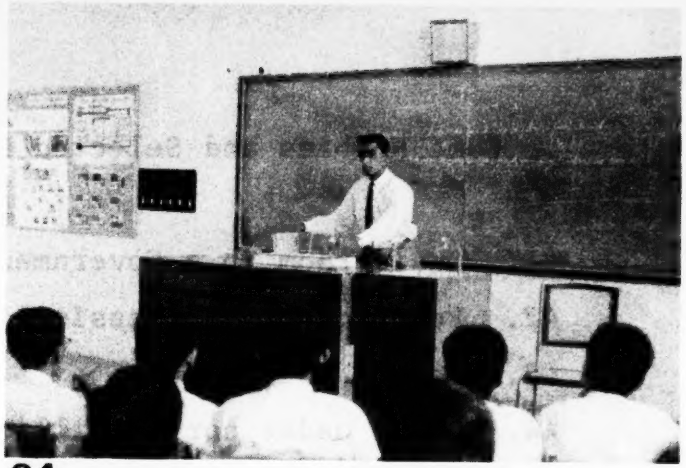

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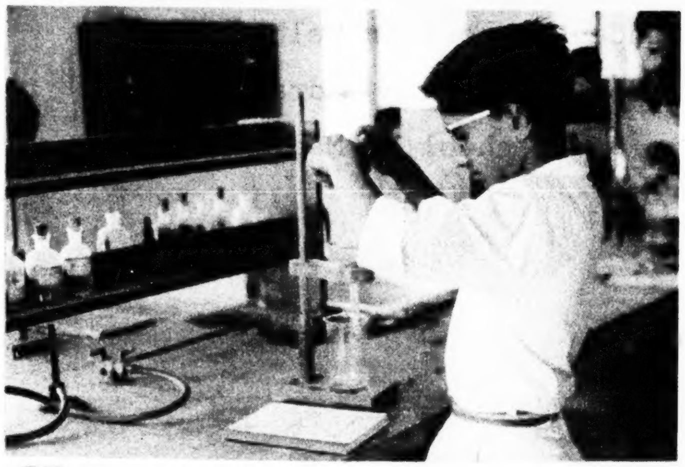

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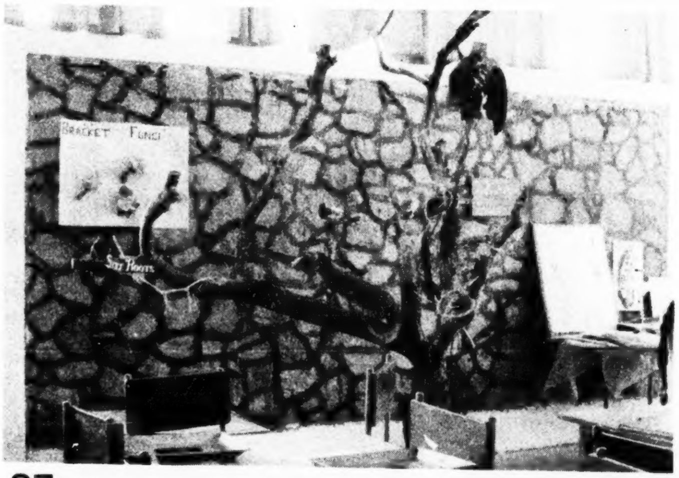
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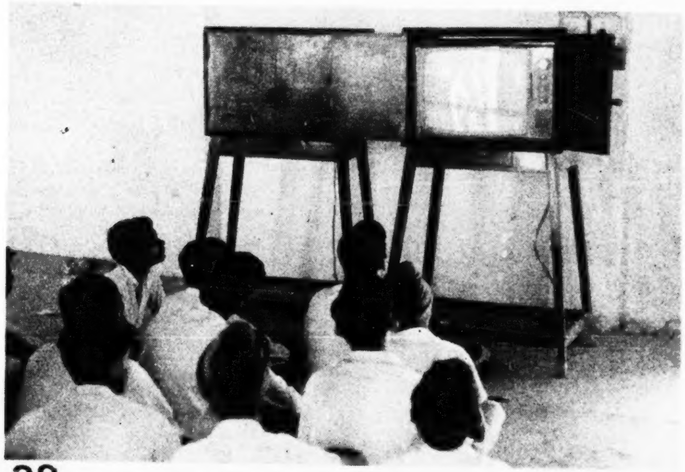

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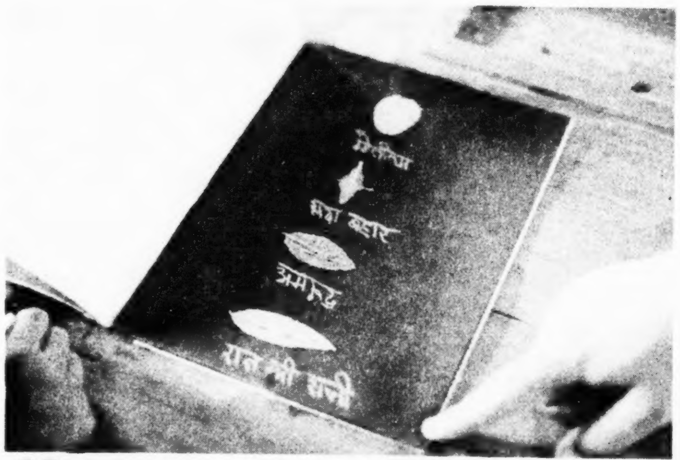

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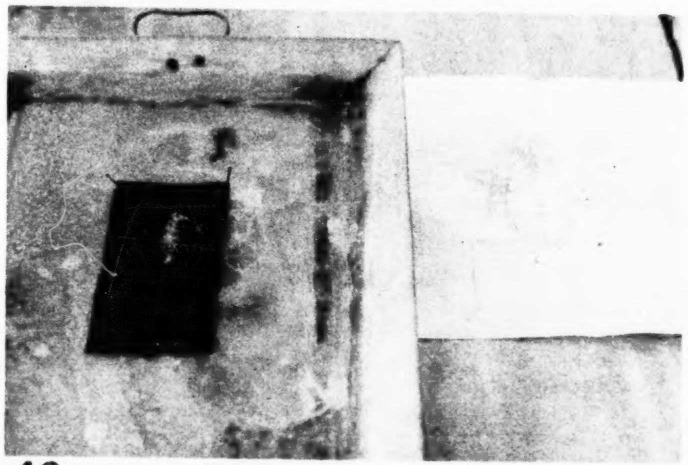

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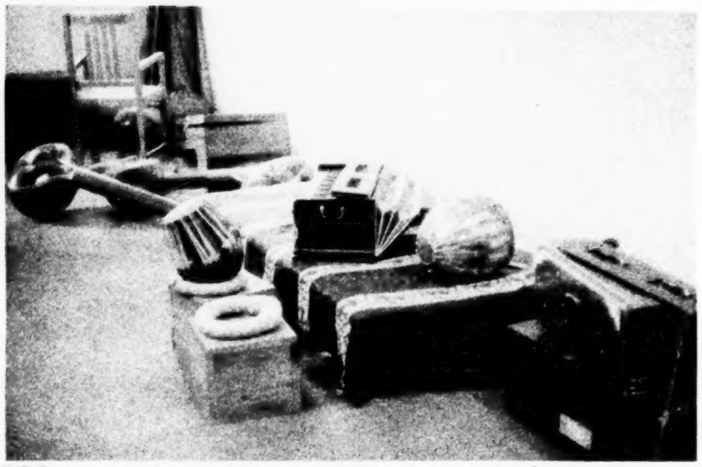
Plate VI. Some Hobbies and Selected Non-Science Activities in High Schools

41. Music room in a Government Girls' High School in Delhi
42. Performance of classical music
43. German folk dance
44. Civil cadet corps drilling in a Delhi school
45. Pottery lesson in an independent school in Delhi
46. Wood craft lesson in an independent school in Delhi
47. Garden organised by school gardening club in Madras
48. Pupils borrow from the library of a school in Madras during their free time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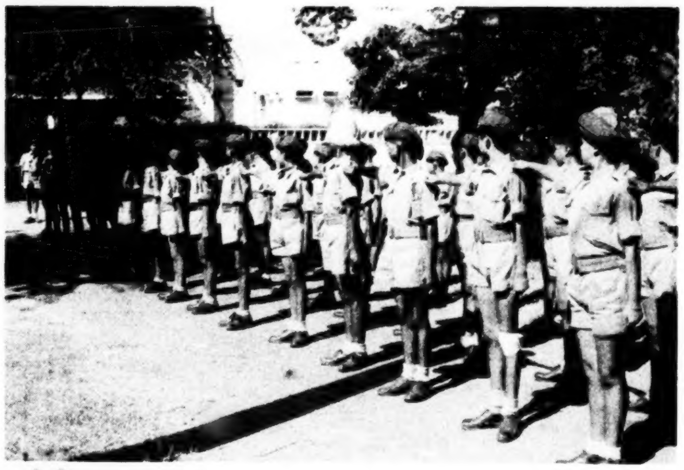
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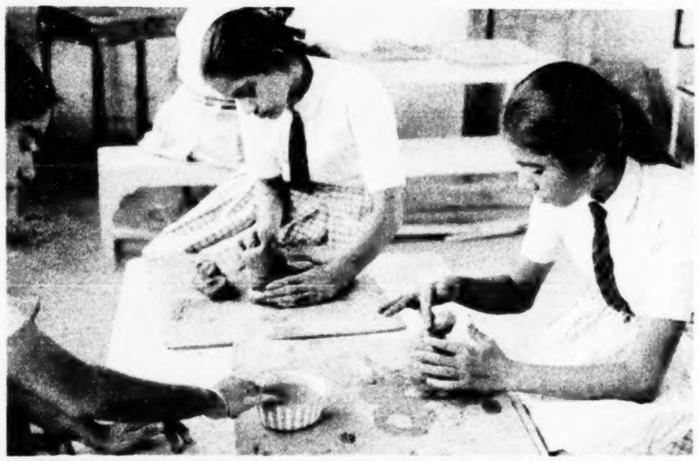
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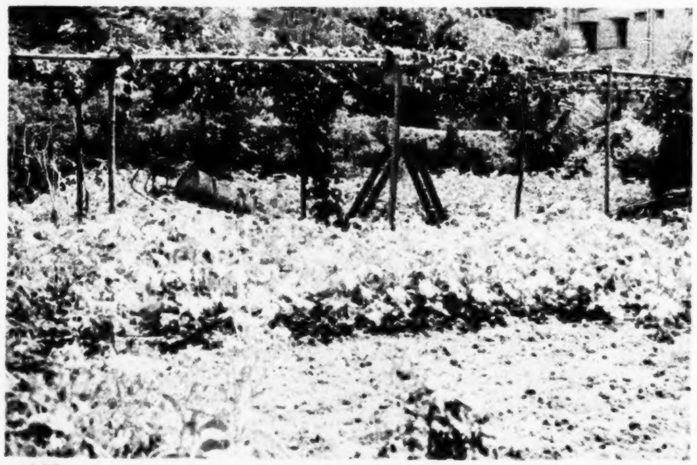
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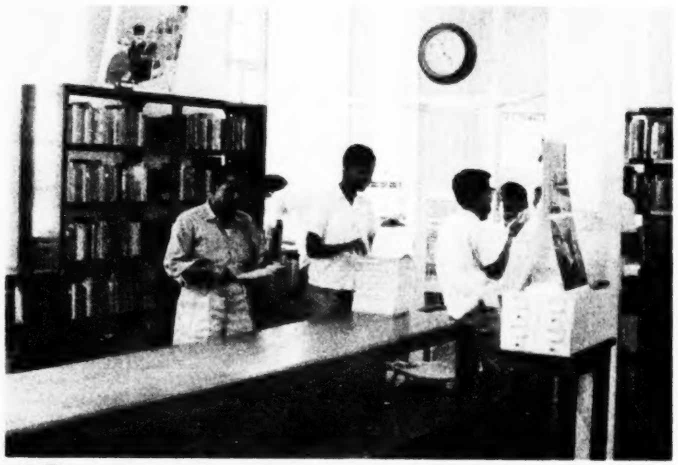
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